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(54) **RECORDING MEDIUM HAVING RECORDED THEREIN VIRTUAL MACHINE MANAGEMENT PROGRAM, MANAGEMENT SERVER APPARATUS AND VIRTUAL MACHINE MANAGEMENT METHOD**

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(57) **ABSTRACT**

A virtual machine managing method includes: virtual machine list generation step of detecting a plurality of virtual machines deployed on a physical machine; a dependency list generation step of detecting dependencies among the virtual machines deployed on the physical machine; a power-off order generation step of, based on table contents of the virtual machine list table and the dependency list table, generating a power-off order management table which manages a power-off order in which the same virtual machines are sequentially powered off in descending order of dependency, in units of the physical machine; and a target presentation step of, when an instruction for selecting the power-off target physical machine is detected, reading the power-off order corresponding to this power-off target physical machine from the power-off order management table, and visually presenting this read power-off order.

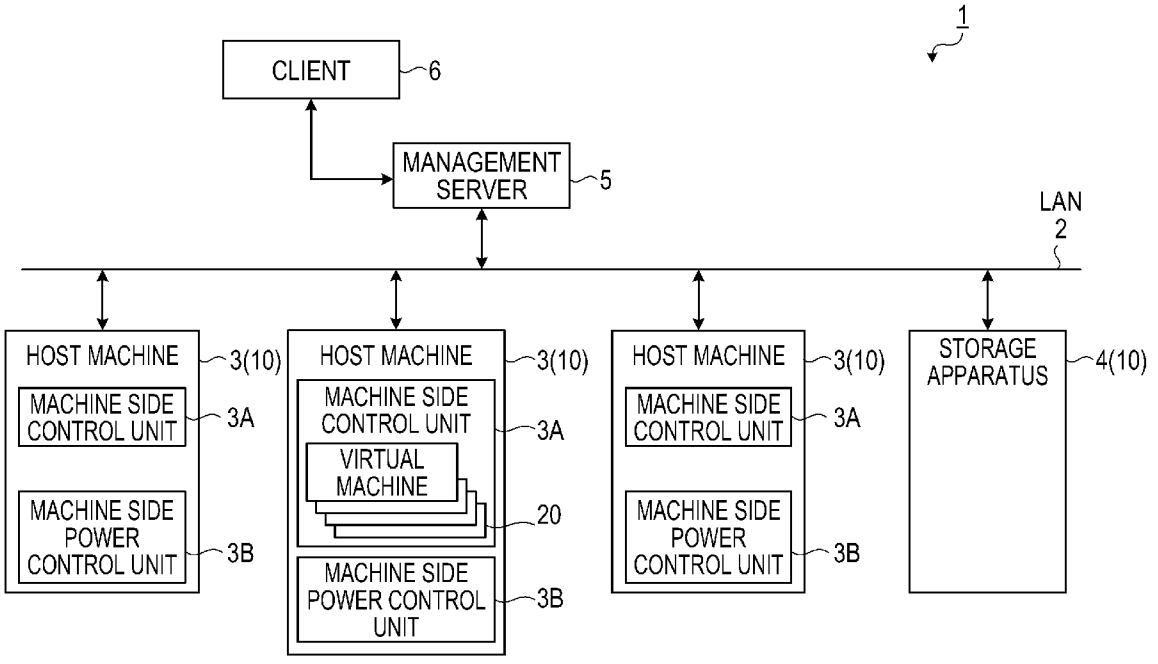


FIG. 1

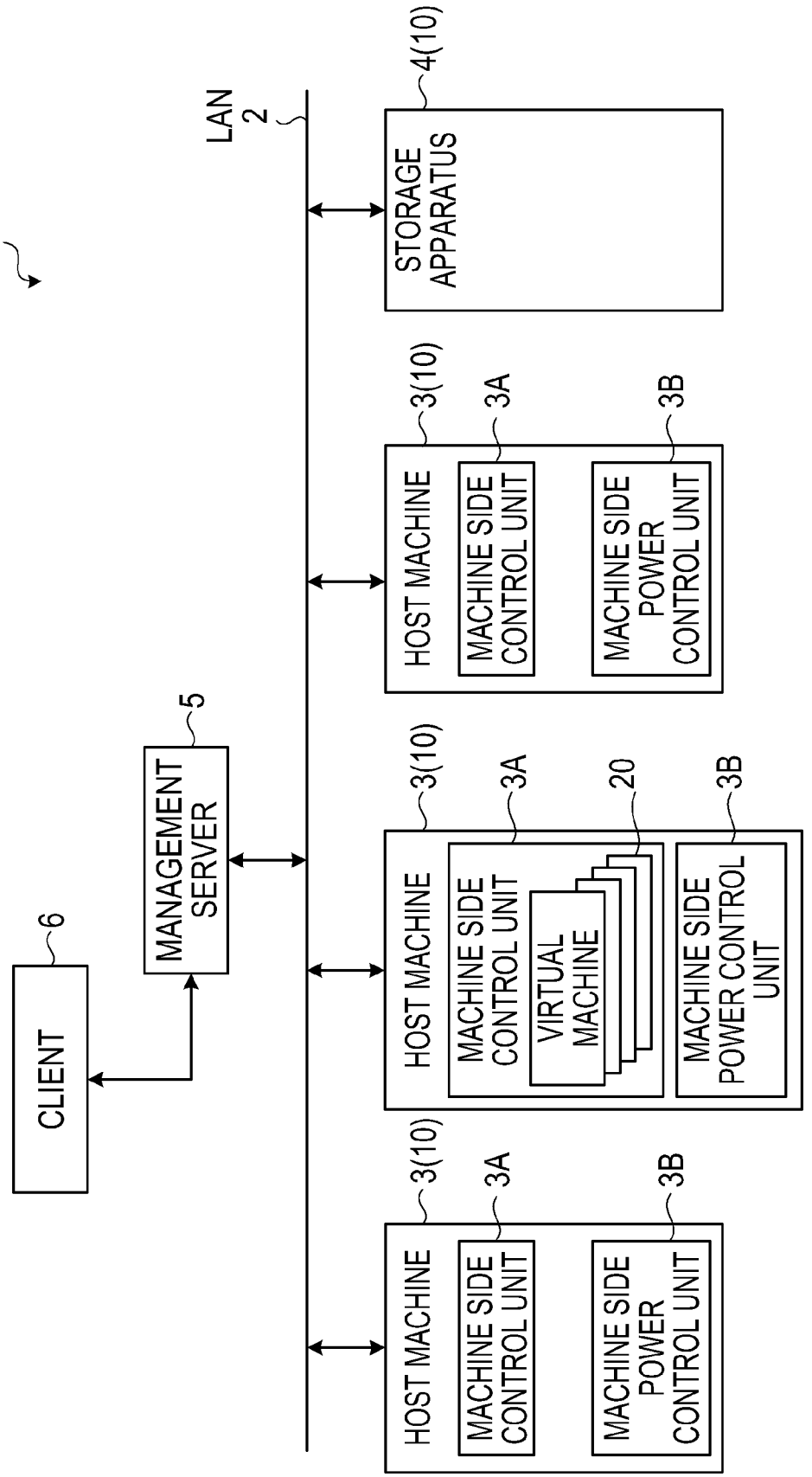

1
LAN
2
4(10)
STORAGE APPARATUS
3(10)
3A
3B
HOST MACHINE
MACHINE SIDE CONTROL UNIT
MACHINE SIDE POWER CONTROL UNIT
5
MANAGEMENT SERVER
6
CLIENT
20
VIRTUAL MACHINE

FIG. 2

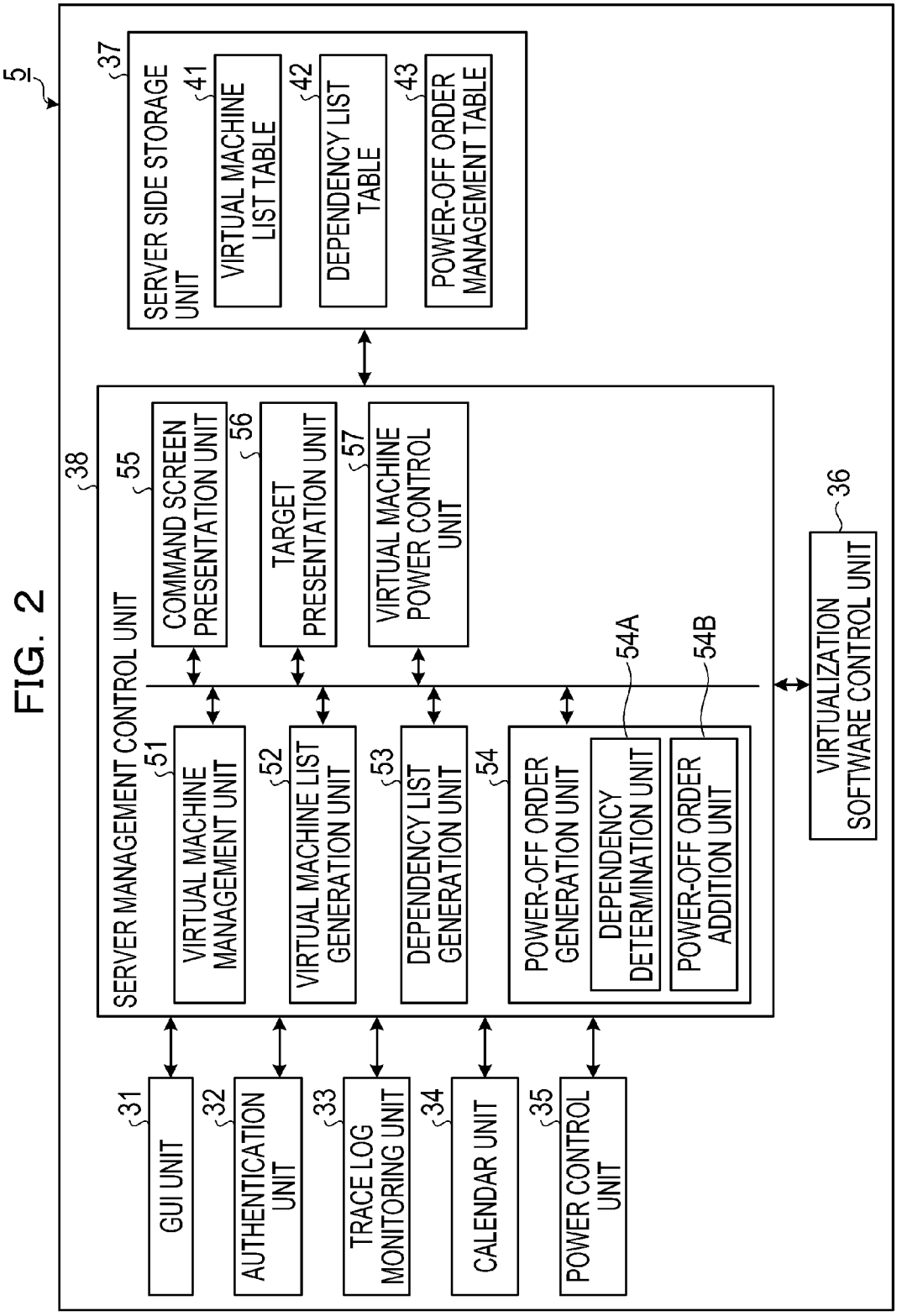

5
37
SERVER SIDE STORAGE UNIT
41
VIRTUAL MACHINE LIST TABLE
42
DEPENDENCY LIST TABLE
43
POWER-OFF ORDER MANAGEMENT TABLE
38
SERVER MANAGEMENT CONTROL UNIT
55
COMMAND SCREEN PRESENTATION UNIT
56
TARGET PRESENTATION UNIT
57
VIRTUAL MACHINE POWER CONTROL UNIT
51
VIRTUAL MACHINE MANAGEMENT UNIT
52
VIRTUAL MACHINE LIST GENERATION UNIT
53
DEPENDENCY LIST GENERATION UNIT
54
POWER-OFF ORDER GENERATION UNIT
54A
DEPENDENCY DETERMINATION UNIT
54B
POWER-OFF ORDER ADDITION UNIT
36
VIRTUALIZATION SOFTWARE CONTROL UNIT
31
GUI UNIT
32
AUTHENTICATION UNIT
33
TRACE LOG MONITORING UNIT
34
CALENDAR UNIT
35
POWER CONTROL UNIT

FIG. 3

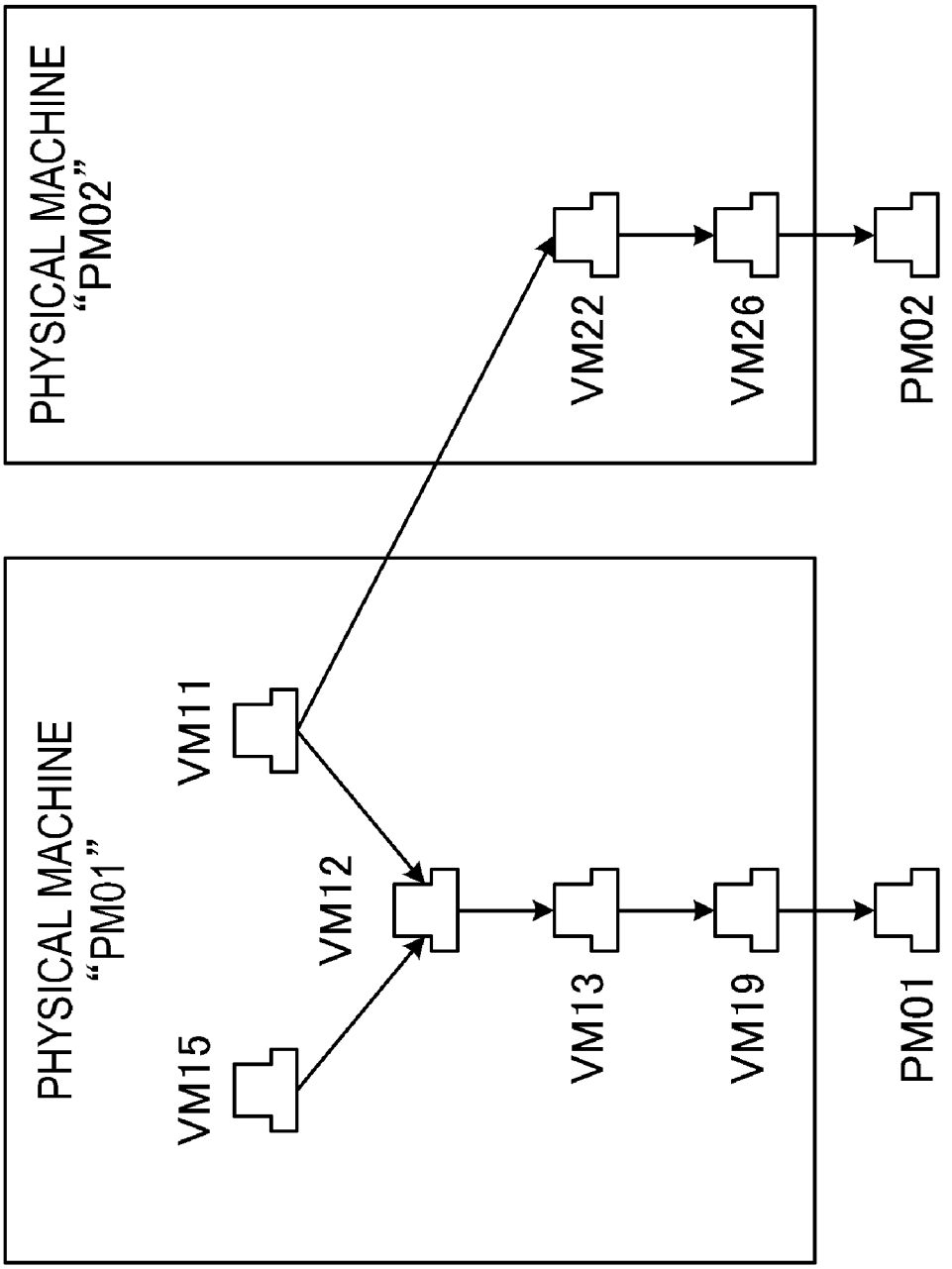

PHYSICAL MACHINE
"PM02"
VM22
VM26
PM02
PHYSICAL MACHINE
"PM01"
VM11
VM12
VM15
VM13
VM19
PM01

FIG. 4

41

PHYSICAL MACHINE	VIRTUAL MACHINES OPERATING ON PHYSICAL MACHINE
PM01	VM11、VM12、VM13、VM15、VM19
PM02	VM22、VM26
PM03	VM31、VM35、VM37、VM39
PM04	VM43、VM45、VM46、VM47
PM05	VM51、VM59
PM06	VM62、VM65

FIG. 5

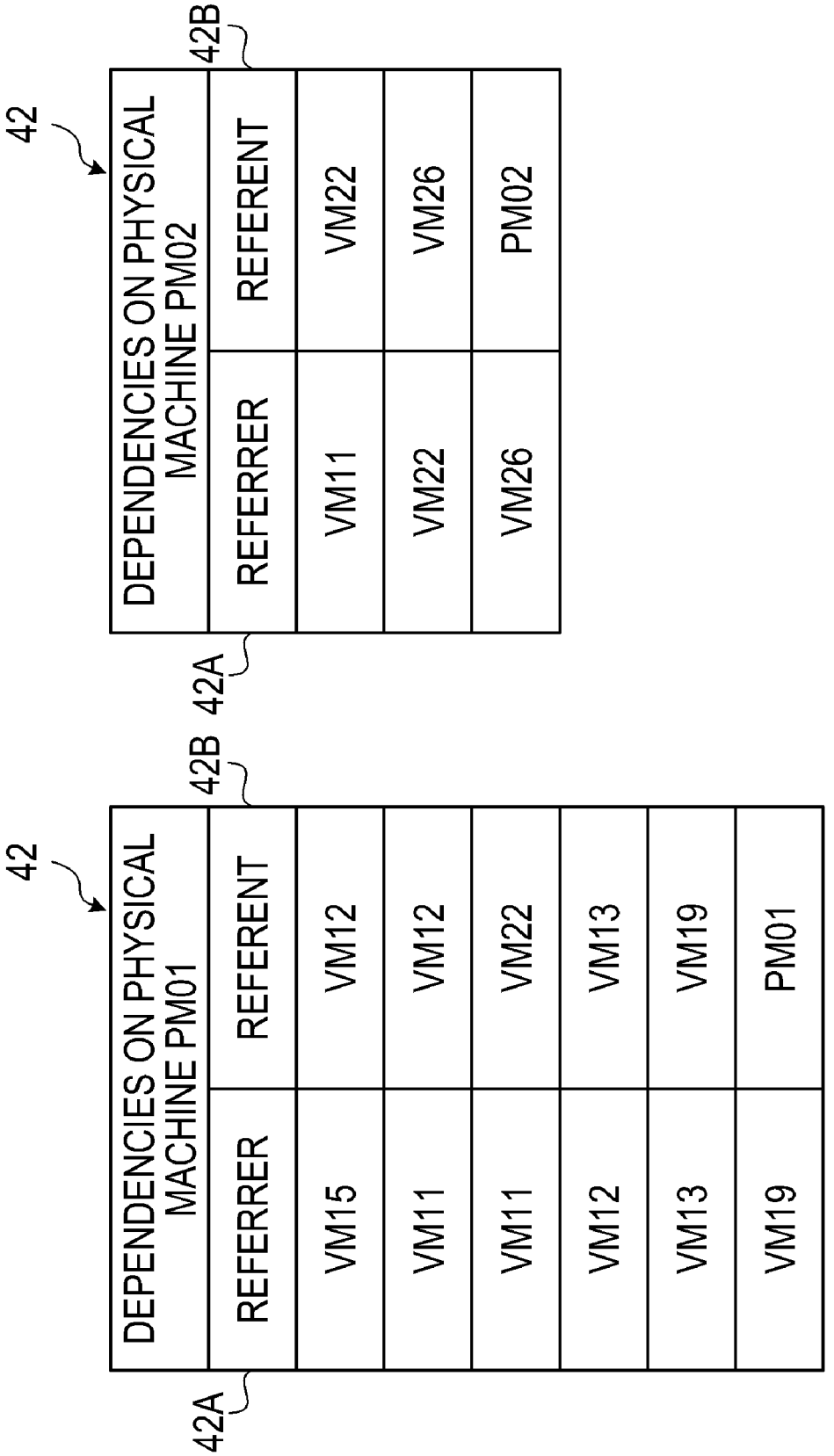

42
DEPENDENCIES ON PHYSICAL MACHINE PM01
42A
42B
REFERRER
REFERENT
VM15
VM12
VM11
VM12
VM11
VM22
VM12
VM13
VM13
VM19
VM19
PM01
42
DEPENDENCIES ON PHYSICAL MACHINE PM02
42A
42B
REFERRER
REFERENT
VM11
VM22
VM22
VM26
VM26
PM02

FIG. 6

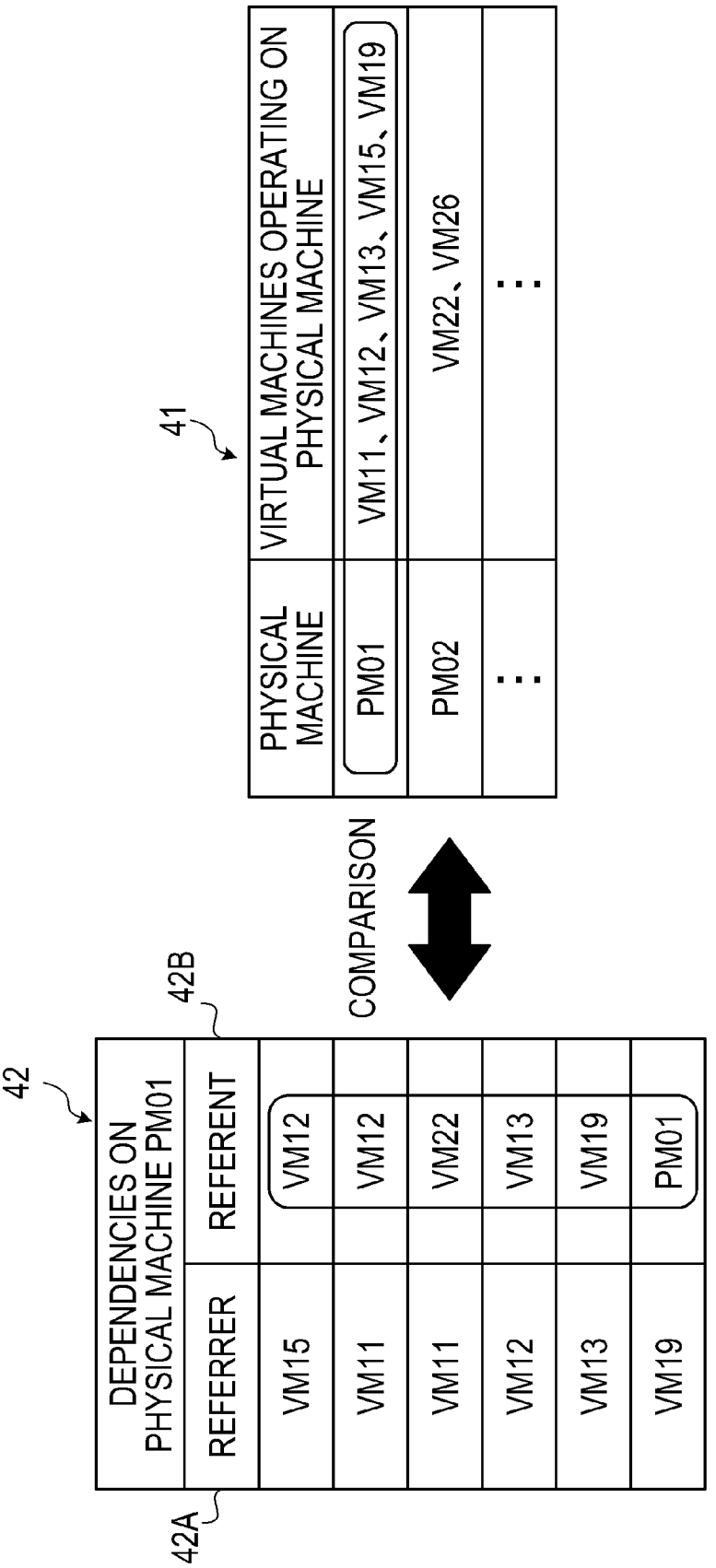

41
PHYSICAL MACHINE
VIRTUAL MACHINES OPERATING ON PHYSICAL MACHINE
PM01
VM11、VM12、VM13、VM15、VM19
PM02
VM22、VM26
COMPARISON
42
42A
42B
DEPENDENCIES ON PHYSICAL MACHINE PM01
REFERRER
REFERENT
VM15
VM12
VM11
VM12
VM11
VM22
VM12
VM13
VM13
VM19
VM19
PM01

FIG. 7

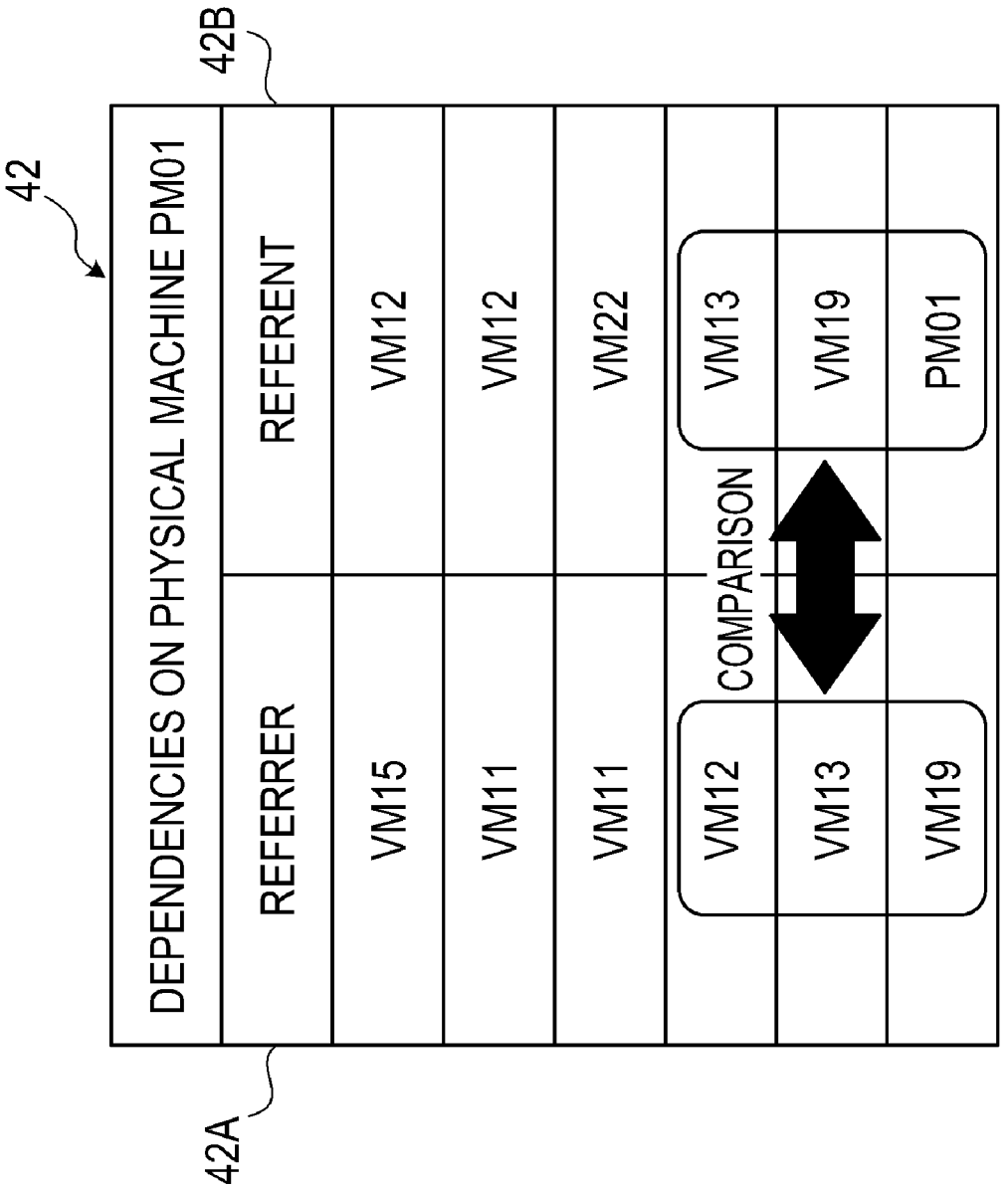

42
42B
42A
DEPENDENCIES ON PHYSICAL MACHINE PM01
REFERRER
REFERENT
VM15
VM11
VM11
VM12
VM12
VM22
VM12
VM13
VM19
COMPARISON
VM13
VM19
PM01

FIG. 8

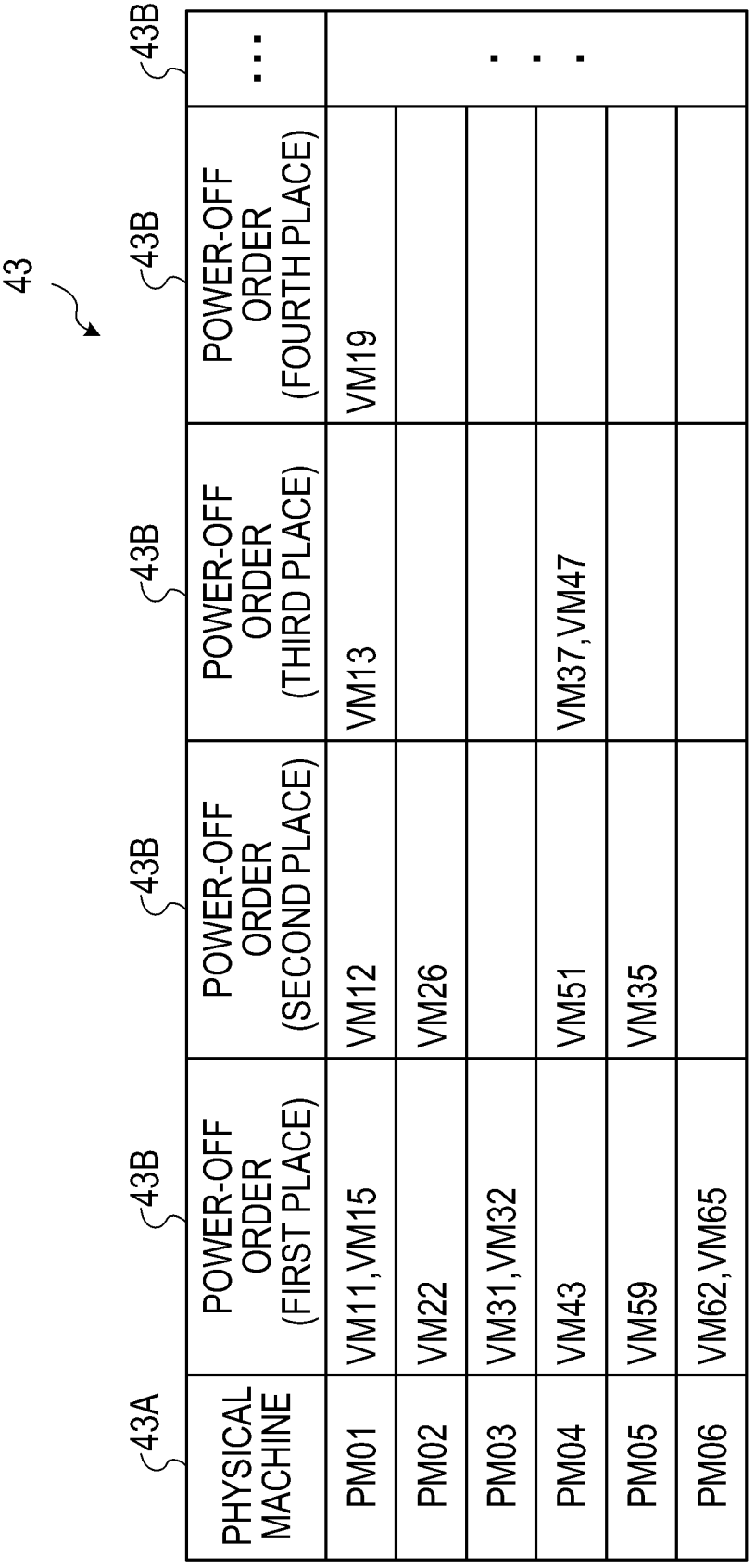

43
43A
43B
43B
43B
43B
PHYSICAL MACHINE
POWER-OFF ORDER (FIRST PLACE)
POWER-OFF ORDER (SECOND PLACE)
POWER-OFF ORDER (THIRD PLACE)
POWER-OFF ORDER (FOURTH PLACE)
PM01
VM11,VM15
VM12
VM13
VM19
PM02
VM22
VM26
PM03
VM31,VM32
PM04
VM43
VM51
VM37,VM47
PM05
VM59
VM35
PM06
VM62,VM65

FIG. 9

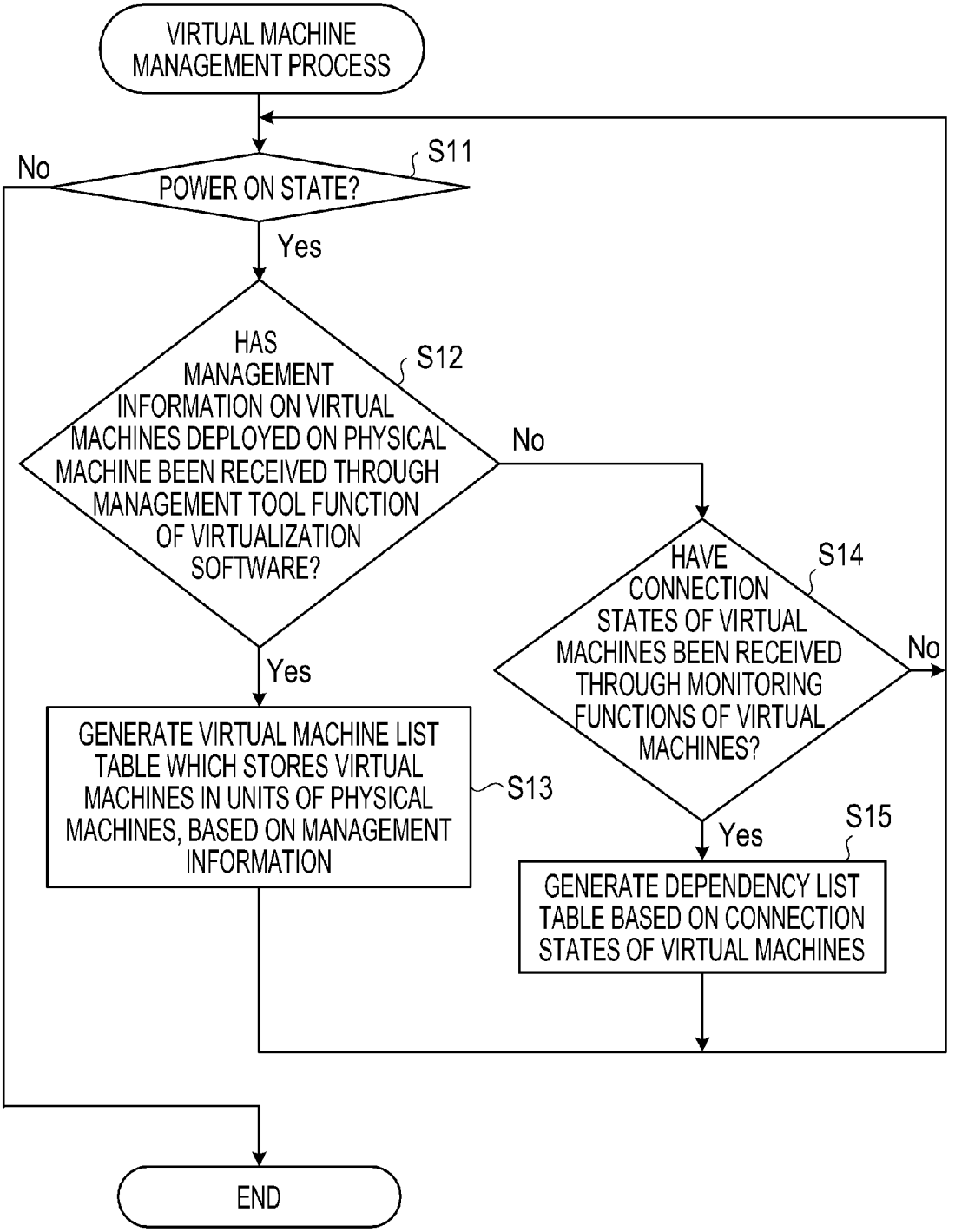

VIRTUAL MACHINE MANAGEMENT PROCESS
S11
POWER ON STATE?
No
Yes
S12
HAS MANAGEMENT INFORMATION ON VIRTUAL MACHINES DEPLOYED ON PHYSICAL MACHINE BEEN RECEIVED THROUGH MANAGEMENT TOOL FUNCTION OF VIRTUALIZATION SOFTWARE?
No
Yes
S14
HAVE CONNECTION STATES OF VIRTUAL MACHINES BEEN RECEIVED THROUGH MONITORING FUNCTIONS OF VIRTUAL MACHINES?
No
Yes
S13
GENERATE VIRTUAL MACHINE LIST TABLE WHICH STORES VIRTUAL MACHINES IN UNITS OF PHYSICAL MACHINES, BASED ON MANAGEMENT INFORMATION
S15
GENERATE DEPENDENCY LIST TABLE BASED ON CONNECTION STATES OF VIRTUAL MACHINES
END

FIG. 10

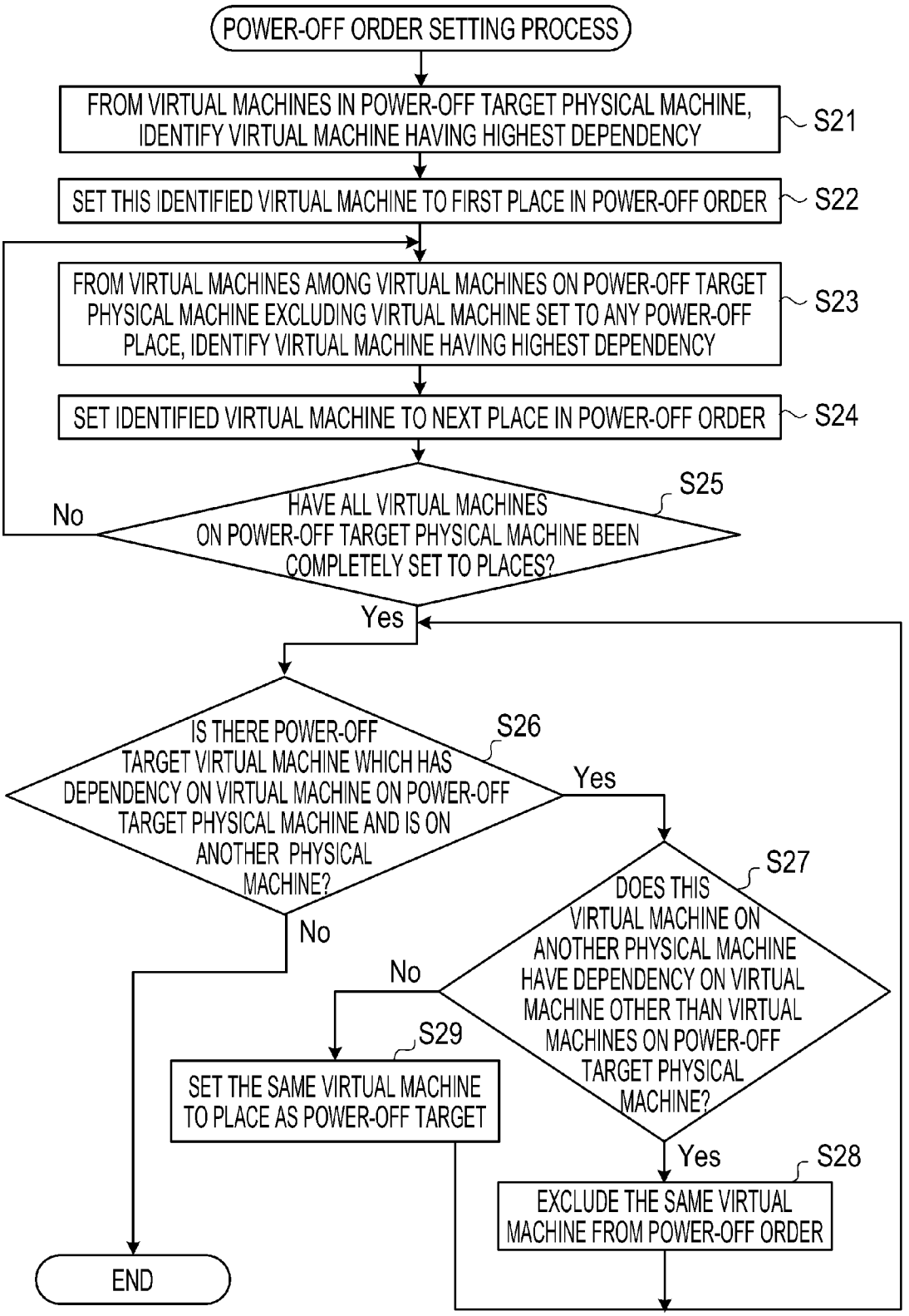

POWER-OFF ORDER SETTING PROCESS
FROM VIRTUAL MACHINES IN POWER-OFF TARGET PHYSICAL MACHINE, IDENTIFY VIRTUAL MACHINE HAVING HIGHEST DEPENDENCY
S21
SET THIS IDENTIFIED VIRTUAL MACHINE TO FIRST PLACE IN POWER-OFF ORDER
S22
FROM VIRTUAL MACHINES AMONG VIRTUAL MACHINES ON POWER-OFF TARGET PHYSICAL MACHINE EXCLUDING VIRTUAL MACHINE SET TO ANY POWER-OFF PLACE, IDENTIFY VIRTUAL MACHINE HAVING HIGHEST DEPENDENCY
S23
SET IDENTIFIED VIRTUAL MACHINE TO NEXT PLACE IN POWER-OFF ORDER
S24
HAVE ALL VIRTUAL MACHINES ON POWER-OFF TARGET PHYSICAL MACHINE BEEN COMPLETELY SET TO PLACES?
S25
No
Yes
IS THERE POWER-OFF TARGET VIRTUAL MACHINE WHICH HAS DEPENDENCY ON VIRTUAL MACHINE ON POWER-OFF TARGET PHYSICAL MACHINE AND IS ON ANOTHER PHYSICAL MACHINE?
S26
Yes
No
DOES THIS VIRTUAL MACHINE ON ANOTHER PHYSICAL MACHINE HAVE DEPENDENCY ON VIRTUAL MACHINE OTHER THAN VIRTUAL MACHINES ON POWER-OFF TARGET PHYSICAL MACHINE?
S27
No
Yes
SET THE SAME VIRTUAL MACHINE TO PLACE AS POWER-OFF TARGET
S29
EXCLUDE THE SAME VIRTUAL MACHINE FROM POWER-OFF ORDER
S28
END

FIG. 11

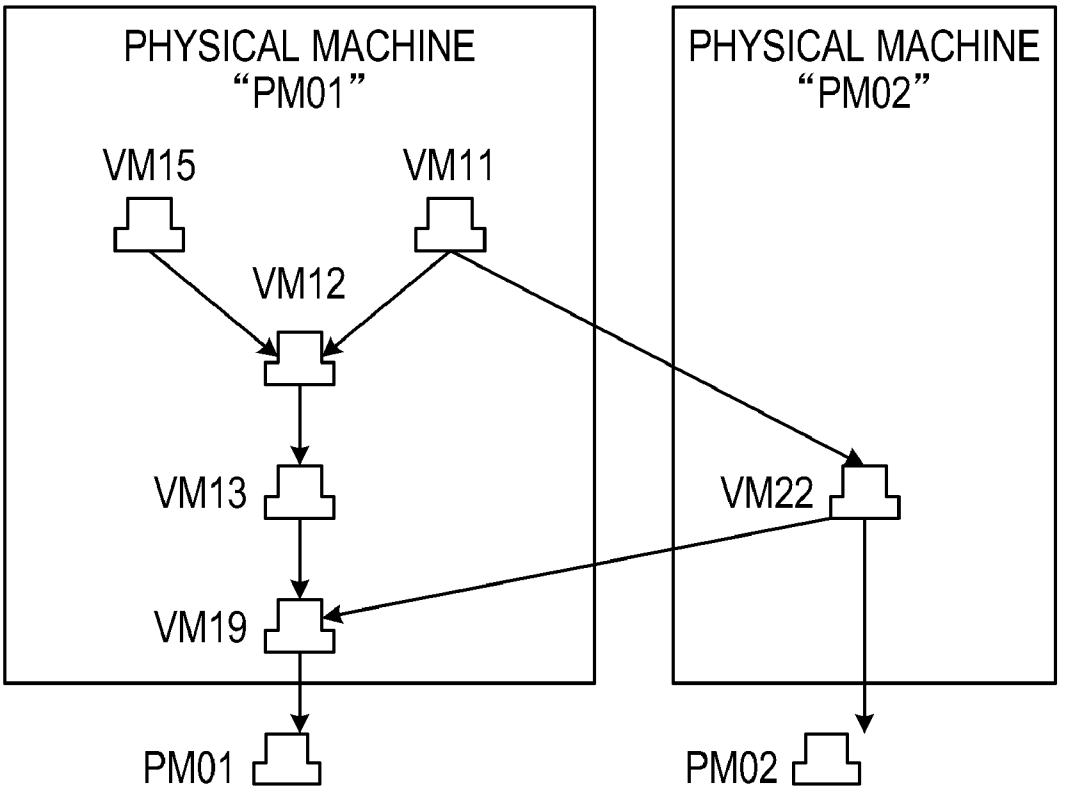

PHYSICAL MACHINE
“PM01”
PHYSICAL MACHINE
“PM02”
VM15
VM11
VM12
VM13
VM22
VM19
PM01
PM02

FIG. 12

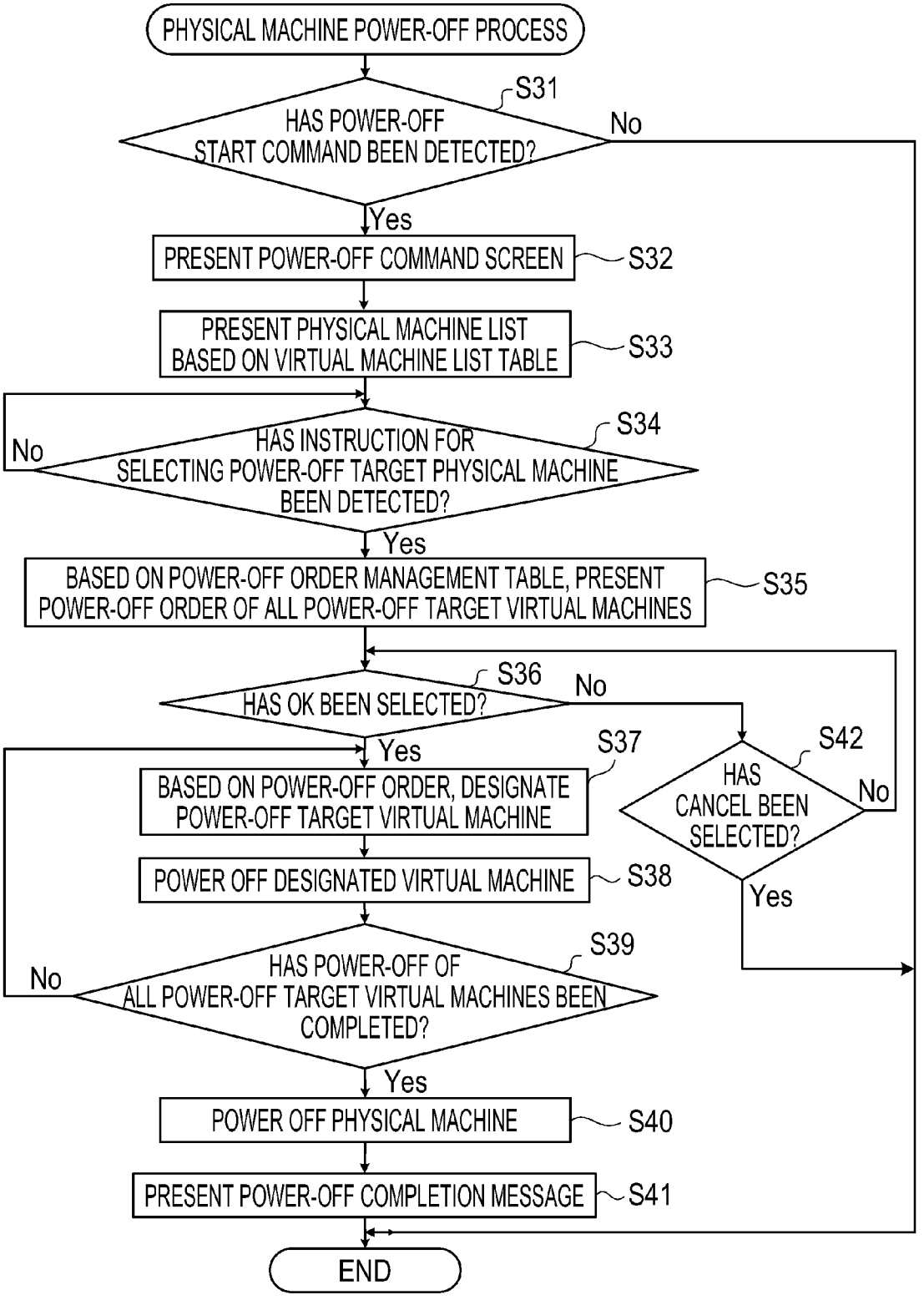

PHYSICAL MACHINE POWER-OFF PROCESS
S31
HAS POWER-OFF START COMMAND BEEN DETECTED?
No
Yes
PRESENT POWER-OFF COMMAND SCREEN
S32
PRESENT PHYSICAL MACHINE LIST BASED ON VIRTUAL MACHINE LIST TABLE
S33
S34
No
HAS INSTRUCTION FOR SELECTING POWER-OFF TARGET PHYSICAL MACHINE BEEN DETECTED?
Yes
BASED ON POWER-OFF ORDER MANAGEMENT TABLE, PRESENT POWER-OFF ORDER OF ALL POWER-OFF TARGET VIRTUAL MACHINES
S35
S36
HAS OK BEEN SELECTED?
No
Yes
S37
BASED ON POWER-OFF ORDER, DESIGNATE POWER-OFF TARGET VIRTUAL MACHINE
S42
HAS CANCEL BEEN SELECTED?
No
Yes
POWER OFF DESIGNATED VIRTUAL MACHINE
S38
S39
No
HAS POWER-OFF OF ALL POWER-OFF TARGET VIRTUAL MACHINES BEEN COMPLETED?
Yes
POWER OFF PHYSICAL MACHINE
S40
PRESENT POWER-OFF COMPLETION MESSAGE
S41
END

FIG. 13

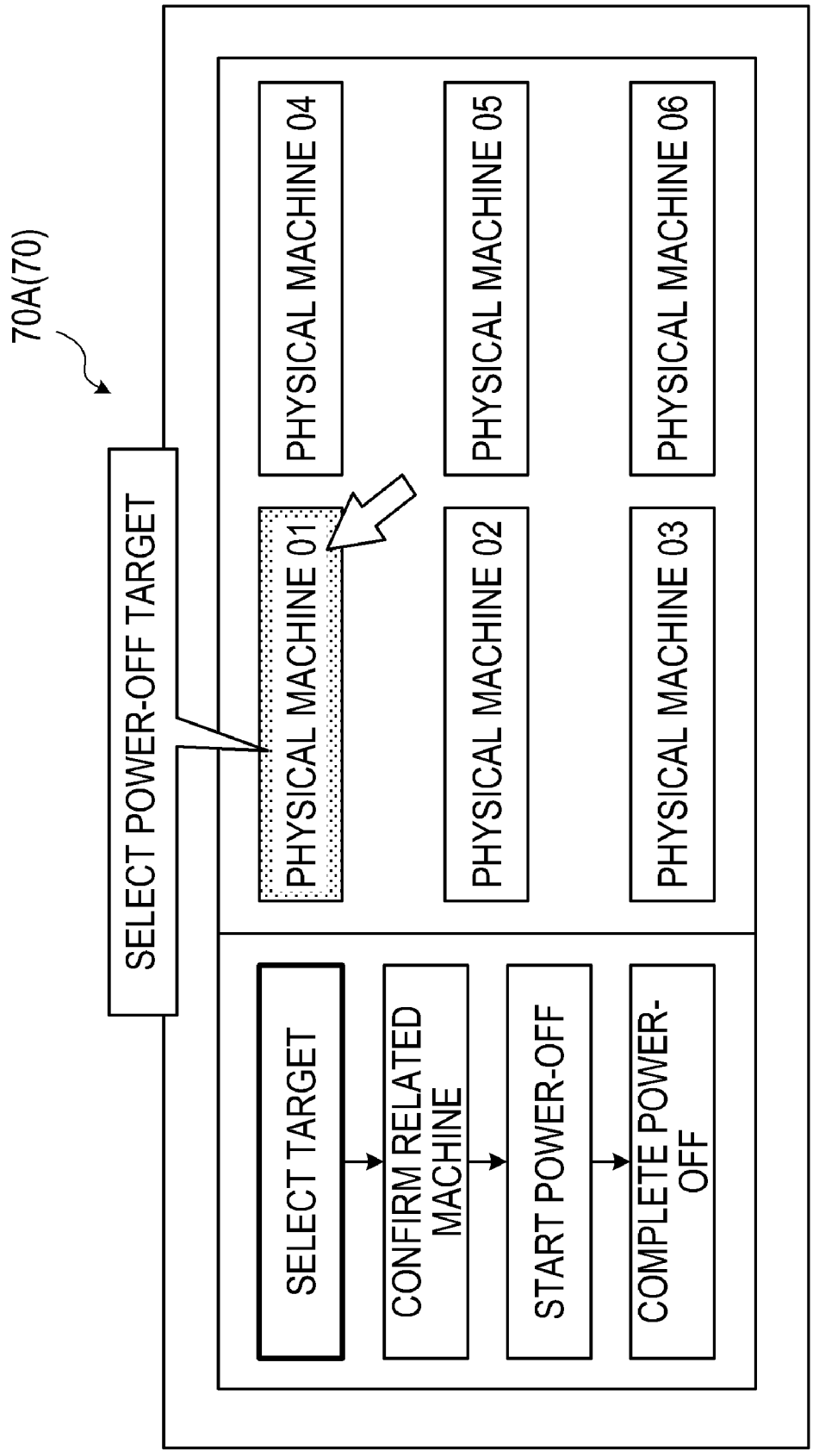
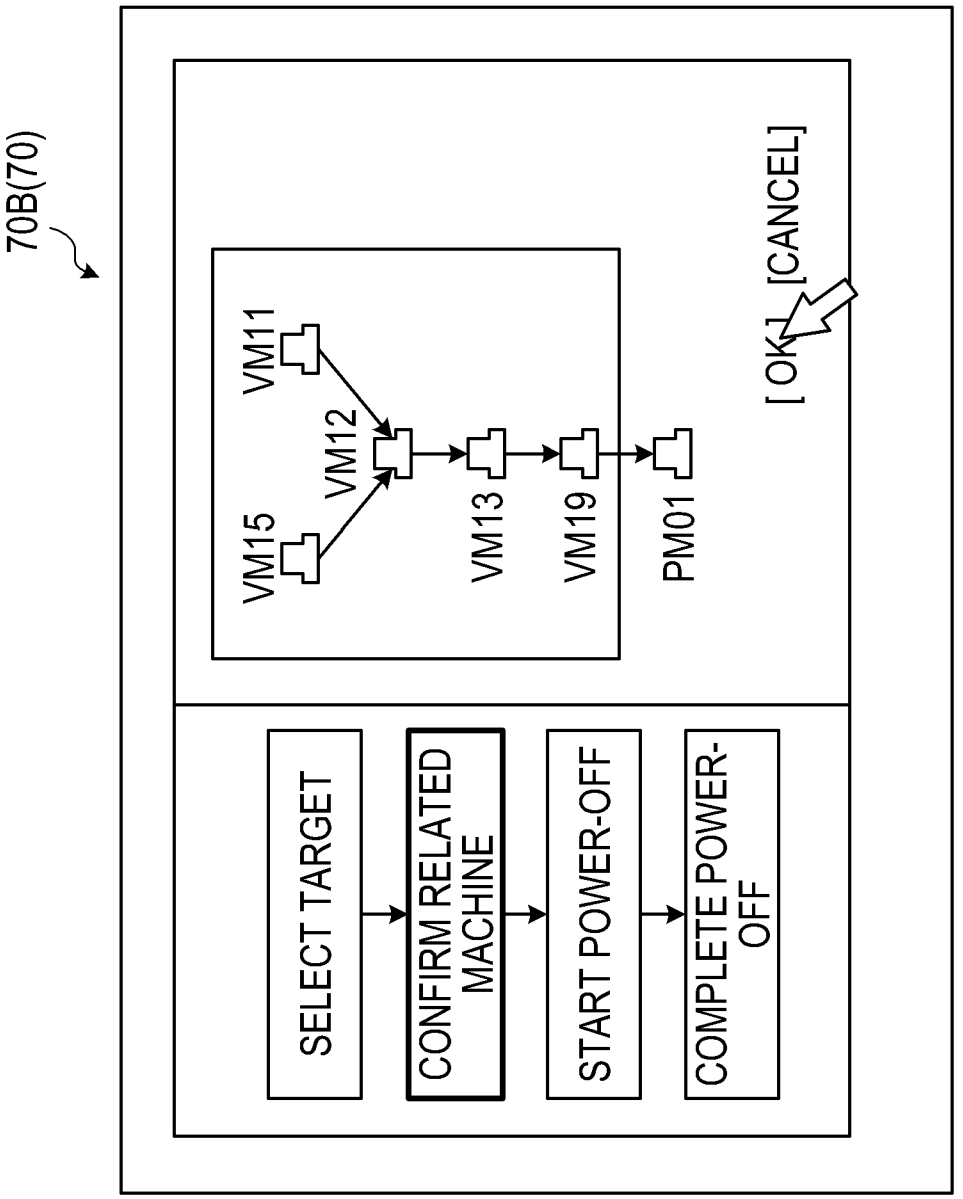

70A(70)
SELECT POWER-OFF TARGET
PHYSICAL MACHINE 01
PHYSICAL MACHINE 02
PHYSICAL MACHINE 03
PHYSICAL MACHINE 04
PHYSICAL MACHINE 05
PHYSICAL MACHINE 06
SELECT TARGET
CONFIRM RELATED MACHINE
START POWER-OFF
COMPLETE POWER-OFF

FIG. 14


70B(70)
VM11
VM12
VM15
VM13
VM19
PM01
[OK]
[CANCEL]
SELECT TARGET
CONFIRM RELATED MACHINE
START POWER-OFF
COMPLETE POWER-OFF

RECORDING MEDIUM HAVING RECORDED THEREIN VIRTUAL MACHINE MANAGEMENT PROGRAM, MANAGEMENT SERVER APPARATUS AND VIRTUAL MACHINE MANAGEMENT METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2008-93078, filed on Mar. 31, 2008 the entire contents of which are incorporated herein by reference.

FIELD

[0002] The present invention relates to a recording medium having recorded therein a virtual machine management program for causing a computer apparatus which causes arbitrary virtual machines among a plurality of virtual machines deployed on a physical machine such as, for example, a host machine to execute a control process in cooperation with one another, to execute a process of managing the above described plurality of virtual machines, as well as a management server apparatus and a virtual machine management method.

BACKGROUND

[0003] Conventionally, as such a management server apparatus, there is a well-known technique for managing a physical machine such as, for example, a host machine, and also using virtualization software to manage a plurality of virtual machines deployed on this physical machine, and enabling arbitrary virtual machines among the plurality of virtual machines to execute one control process in cooperation with one another (for example Japanese Patent Laid-Open No. 6-250858).

[0004] Moreover, in such a management server apparatus which deploys the plurality of virtual machines on the physical machine, there are known a technique for separating a processing resource of a virtual machine in response to loss of the same virtual machine, and a technique for determining whether or not there is an additional partition when power-off of a logical partition is requested, and based on a result of this determination, executing the power-off or shut-down (for example National Publication of International Patent Application No. 2004-523048).

[0005] According to such a conventional management server apparatus, if the physical machine is powered off, all the virtual machines deployed on the physical machine of a power-off target need to be powered off in a software manner before this physical machine is powered off. However, of course, cooperative relationships, that is, dependencies among the virtual machines deployed on this power-off target physical machine can be comprehended only by a specific system administrator, and in addition, the virtual machines dynamically move on the physical machine. Therefore, when the power-off target physical machine is powered off, it is very difficult to identify an order in which all the virtual machines having the dependencies should be powered off in a software manner, and in addition, when a user other than the specific system administrator powers off the power-off target physical machine, a complicated operational burden is necessarily imposed on the user.

SUMMARY

[0006] This program is a virtual machine management program for causing a computer apparatus which causes arbitrary virtual machines among a plurality of virtual machines deployed on a physical machine to execute a control process in cooperation with one another, to execute a process of managing the above described plurality of virtual machines. One feature of the virtual machine management program is to cause the above described computer apparatus to execute a virtual machine list generation procedure for detecting the virtual machines deployed on the above described physical machine, and based on a result of this detection, generating a virtual machine list table which manages, in units of physical machine identification information for identifying the above described physical machine, virtual machine identification information for identifying the virtual machines deployed on this physical machine; a dependency list generation procedure for detecting dependencies among the virtual machines deployed on the above described physical machine, and based on a result of this detection, generating a dependency list table which manages, in units of the virtual machine identification information on the above described virtual machines, the virtual machine identification information on the virtual machines having the dependencies on the same virtual machines; a power-off order generation procedure for, based on table contents of the above described virtual machine list table and the above described dependency list table, from the virtual machines deployed on the physical machine of a power-off target and the virtual machines having the dependencies on these virtual machines, generating a power-off order management table which manages a power-off order in which the same virtual machines are sequentially powered off in descending order of dependency, in units of the above described physical machine; and a target presentation procedure for, when an instruction for selecting the above described power-off target physical machine is detected, reading the power-off order corresponding to this power-off target physical machine from the above described power-off order management table, and visually presenting this read power-off order.

[0007] The object and advantages of invention will be realized and attained by means of the elements and combinations particularly pointed out in the claims.

[0008] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a block diagram depicting a schematic configuration of an entire virtual machine management system of the present embodiment;

[0010] FIG. **2** is a block diagram depicting a schematic internal configuration of a management server which is a main portion of the present embodiment;

[0011] FIG. **3** is an explanatory diagram briefly depicting an example of dependencies among virtual machines deployed on physical machines in the present embodiment;

[0012] FIG. **4** is an explanatory diagram briefly depicting table contents of a virtual machine list table in the present embodiment;

[0013] FIG. **5** is an explanatory diagram briefly depicting table contents of a dependency list table (the dependencies depicted in FIG. **3**) in the present embodiment;

[0014] FIG. **6** is an explanatory diagram briefly depicting an operation when a first place in a power-off order is set by using the virtual machine list table and the dependency list table in the present embodiment;

[0015] FIG. **7** is an explanatory diagram briefly depicting an operation when a second place and subsequent places in the power-off order are set by using the dependency list table in the present embodiment;

[0016] FIG. **8** is an explanatory diagram briefly depicting table contents of a power-off order management table in the present embodiment;

[0017] FIG. **9** is a flowchart depicting a processing operation of a server management control unit within the management server, regarding a virtual machine management process in the present embodiment;

[0018] FIG. **10** is a flowchart depicting a processing operation of the server management control unit within the management server, regarding a power-off order setting process in the present embodiment;

[0019] FIG. **11** is an explanatory diagram briefly depicting an example of the dependencies among the virtual machines deployed on the physical machines in the present embodiment;

[0020] FIG. **12** is a flowchart depicting a processing operation of the server management control unit within the management server, regarding a physical machine power-off process in the present embodiment;

[0021] FIG. **13** is an explanatory diagram briefly depicting a power-off command screen at the time of the physical machine power-off process, which is presented to a client side in the present embodiment; and

[0022] FIG. **14** is an explanatory diagram briefly depicting the power-off command screen (power-off order screen) at the time of the physical machine power-off process, which is presented to the client side in the present embodiment.

DESCRIPTION OF EMBODIMENT

[0023] Hereinafter, an embodiment regarding a virtual machine management program, a management server apparatus and a virtual machine management method of the present invention will be described in detail based on the drawings.

[0024] First, a summary of the present embodiment will be described. As the summary thereof, when an instruction for selecting power-off with respect to a physical machine is detected, from virtual machines deployed on the physical machine of a power-off target and virtual machines having dependencies on these virtual machines, a power-off order in which the same virtual machines are sequentially powered off in descending order of dependency is visually presented. Therefore, even a user other than a specific system administrator can identify the power-off order in the power-off target physical machine based on presented contents thereof, and thereby easily power off the power-off target physical machine including the virtual machines dependent on the power-off target physical machine, without any complicated operational burden.

[0025] FIG. **1** is a block diagram depicting a schematic configuration of an entire virtual machine management system of the present embodiment.

[0026] A virtual machine management system **1** depicted in FIG. **1** includes a management server **5** which manages a plurality of host machines **3** and a storage apparatus **4** via a LAN **2**, and a client **6** which operates this management server **5**. The host machine **3** includes a machine side control unit **3**A which controls the entire host machine **3**, and a machine side power control unit **3**B which takes charge of power control of this host machine **3**.

[0027] The host machine **3** uses virtualization software to deploy a plurality of virtual machines **20** on the machine side control unit **3**A, and causes the plurality of virtual machines **20** being deployed, to execute various processes in cooperation with one another.

[0028] Moreover, the management server **5** manages physical machines **10** such as the host machine **3** and the storage apparatus **4**, and also uses a management tool of the virtualization software to manage the plurality of virtual machines **20** deployed on the physical machines **10**.

[0029] Moreover, the management server **5** uses power control software to manage powers of the virtual machines **20** deployed on the physical machines **10**, in a software manner.

[0030] FIG. **2** is a block diagram depicting a schematic internal configuration of the management server **5** of the present embodiment.

[0031] The management server **5** depicted in FIG. **2** includes a GUI (Graphical User Interface) unit **31** which takes charge of a user interface with the client **6**, an authentication unit **32** which cooperates with the management tool of the virtualization software to execute an authentication process, a trace log monitoring unit **33** which manages information collected when a failure occurs and an operational history of an audit trail, a calendar unit **34** which takes charge of a calendar function, and a power control unit **35** which takes charge of power control of, of course, the same management server **5**, and each physical machine **10**.

[0032] The power control unit **35** performs the power control of each physical machine **10** through the machine side power control unit **3**B of each physical machine **10**.

[0033] Moreover, the management server **5** includes a virtualization software control unit **36** which uses the management tool of the virtualization software to monitor and control the plurality of virtual machines **20** deployed on the physical machines **10**, a server side storage unit **37** which stores various information regarding the management server **5**, and a server management control unit **38** which controls this entire management server **5**.

[0034] The server side storage unit **37** includes a virtual machine list table **41** which manages, for each physical machine **10**, the virtual machines **20** deployed on the same physical machine **10**, in a list form in units of the physical machines **10**, a dependency list table **42** which manages dependencies among the virtual machines **20**, in the list form in units of the physical machines **10**, and a power-off order management table **43** which manages, in units of the physical machines **10** of power-off targets, a power-off order of, of course, the virtual machines **20** deployed on the same physical machines **10**, and the virtual machines **20** having the dependencies on these virtual machines **20**.

[0035] It should be noted that although, for convenience of explanation, it is described that the physical machines **10** or the virtual machines **20** are managed in the virtual machine list table **41**, the dependency list table **42** and the power-off order management table **43**, these physical machines **10** and the virtual machines **20** are managed, of course, with physical

machine identification information (PM) for identifying the same physical machines **10** and virtual machine identification information (VM) for identifying the virtual machines **20**.

[0036] The server management control unit **38** includes a virtual machine management unit **51** which manages, for each physical machine **10**, the virtual machines **20** deployed on the same physical machine **10**, through the virtualization software control unit **36**, a virtual machine list generation unit **52** which generates the virtual machine list table **41**, a dependency list generation unit **53** which generates the dependency list table **42**, and a power-off order generation unit **54** which generates the power-off order management table **43**.

[0037] The virtual machine list generation unit **52** collects management information on the virtual machines **20** deployed on the physical machines **10**, through the management tool of the virtualization software, via the virtualization software control unit **36**, and generates the virtual machine list table **41** which manages, for each physical machine **10**, the virtual machines **20** deployed on the same physical machine **10**, in the list form. It should be noted that the management tool of the virtualization software periodically collects the management information on the virtual machines **20** deployed on the physical machines **10**.

[0038] FIG. **3** is an explanatory diagram briefly depicting an example of the dependencies among the virtual machines **20** deployed on the physical machines **10** in the present embodiment, and FIG. **4** is an explanatory diagram briefly depicting table contents of the virtual machine list table **41** in the present embodiment.

[0039] As depicted in FIG. **3**, on the physical machine **10** of "PM**01**", five virtual machines **20** of "VM**11**", "VM**12**", "VM**13**", "VM**15**" and "VM**19**" are being deployed, while on the physical machine **10** of "PM**02**", two virtual machines **20** of "VM**22**" and "VM**26**" are being deployed.

[0040] Moreover, as their dependencies, on the physical machine **10** of "PM**01**", the virtual machine **20** of "VM**19**" is not dependent on any other virtual machine **20**, the virtual machine **20** of "VM**13**" is dependent on the virtual machine **20** of "VM**19**", the virtual machine **20** of "VM**12**" is dependent on the virtual machine **20** of "VM**13**", the virtual machine **20** of "VM**15**" is dependent on the virtual machine **20** of "VM**12**", and the virtual machine **20** of "VM**11**" is dependent on the virtual machine **20** of "VM**12**", and the virtual machine **20** of "VM**22**" on the physical machine **10** of "PM**02**".

[0041] Moreover, on the physical machine **10** of "PM**02**", the virtual machine **20** of "VM**26**" is not dependent on any other virtual machine **20**, and the virtual machine **20** of "VM**22**" is dependent on the virtual machine **20** of "VM**26**".

[0042] The virtual machine list table **41** depicted in FIG. **4** manages, for each physical machine **10**, the virtual machines **20** deployed on the same physical machine **10**, in the list form. As a result, based on the table contents of the virtual machine list table **41**, the server management control unit **38** can recognize that, for example, on the physical machine **10** of "PM**01**", the five virtual machines **20** of "VM**11**", "VM**12**", "VM**13**", "VM**15**" and "VM**19**" are being deployed, while on the physical machine **10** of "PM**02**", the two virtual machines **20** of "VM**22**" and "VM**26**" are being deployed.

[0043] Moreover, the dependency list generation unit **53** collects information on connection destinations among the virtual machines **20**, through monitoring functions of the virtual machines **20** via the virtualization software control unit **36**, and based on these collected connection states of the virtual machines **20**, generates the dependency list table **42** which manages the information on the connection destinations among the virtual machines **20** in a one-to-one manner in the list form, in units of the physical machines **10**. It should be noted that the monitoring function of the virtual machine **20** is installed in each virtual machine **20**, and periodically confirms the information on the connection destinations among the virtual machines **20**.

[0044] FIG. **5** is an explanatory diagram briefly depicting table contents of the dependency list table **42** (the dependencies depicted in FIG. **3**) in the present embodiment.

[0045] The dependency list table **42** depicted in FIG. **5** manages the information on the connection destinations among the virtual machines **20** being deployed on each physical machine **10**, as a referrer **42**A and a referent **42**B in a one-to-one manner in the list form, in units of the physical machines **10**. As a result, based on the table contents of the dependency list table **42**, the server management control unit **38** can recognize the dependencies among the virtual machines **20** in which, for example, between the virtual machine **20** of "VM**15**" and the virtual machine **20** of "VM**12**", the virtual machine **20** of "VM**15**" is dependent on the virtual machine **20** of "VM**12**" (see FIG. **3**), and therefore, the virtual machine **20** of "VM**15**" is the referrer **42**A and the virtual machine **20** of "VM**12**" is the referent **42**B, and for example, between the virtual machine **20** of "VM**12**" and the virtual machine **20** of "VM**13**", the virtual machine **20** of "VM**12**" is dependent on the virtual machine **20** of "VM**13**" (see FIG. **3**), and therefore, the virtual machine **20** of "VM**12**" is the referrer **42**A and the virtual machine **20** of "VM**13**" is the referent **42**B.

[0046] Moreover, based on the table contents of the virtual machine list table **41** depicted in FIG. **4** and the dependency list table **42** depicted in FIG. **5**, the power-off order generation unit **54** generates the power-off order management table **43** which manages the power-off order of the virtual machines **20** in descending order of dependency, in units of the physical machines **10**.

[0047] FIG. **6** is an explanatory diagram briefly depicting an operation when a first place in the power-off order is set by using the virtual machine list table **41** and the dependency list table **42** in the present embodiment, and FIG. **7** is an explanatory diagram briefly depicting an operation when a second place and subsequent places in the power-off order are set by using the dependency list table **42** in the present embodiment.

[0048] As depicted in FIG. **6**, the power-off order generation unit **54** identifies, from the virtual machines **20** corresponding to the power-off target physical machine **10** in the virtual machine list table **41**, a virtual machine **20** which does not exist in a column of the referent **42**B within the dependency list table **42** corresponding to this power-off target physical machine **10**, as the virtual machine **20** having a highest dependency.

[0049] The power-off order generation unit **54** sets this identified virtual machine **20** to the first place in the power-off order in the same power-off target physical machine **10**. It should be noted that, in the power-off order generation unit **54**, in the case of FIG. **6**, the virtual machines **20** of "VM**11**" and "VM**15**" are set to the first place in the power-off order.

[0050] Next, when the power-off order generation unit **54** has set the first place in the power-off order in the power-off target physical machine **10**, as depicted in FIG. **7**, the power-off order generation unit **54** compares a column of the referrer **42**A with the column of the referent **42**B, excluding the

dependencies of the virtual machines **20** set to this first place, within the dependency list table **42** corresponding to this power-off target physical machine **10**.

[0051] The power-off order generation unit **54** identifies a virtual machine **20** which does not exist in the column of the referent **42**B, from the virtual machines **20** in the column of the referrer **42**A, as the virtual machine **20** having a higher dependency.

[0052] The power-off order generation unit **54** sets this identified virtual machine **20** to the second place in the power-off order. It should be noted that, in the power-off order generation unit **54**, in the case of FIG. **7**, the virtual machine **20** of "VM**12**" is set to the second place in the power-off order.

[0053] Furthermore, the power-off order generation unit **54** compares the column of the referrer **42**A with the column of the referent **42**B, excluding the dependencies of these virtual machines **20** set to the first place and the second place, and identifies a virtual machine **20** which does not exist in the column of the referent **42**B, from the virtual machines **20** in the column of the referrer **42**A, as the virtual machine **20** having the higher dependency.

[0054] The power-off order generation unit **54** sets this identified virtual machine **20** to a third place in the power-off order. It should be noted that, in the power-off order generation unit **54**, in the case of FIG. **7**, the virtual machine **20** of "VM**13**" is set to the third place in the power-off order. Furthermore, when the power-off order generation unit **54** repeats a similar process, the virtual machine **20** of "VM**19**" is set to a fourth place in the power-off order.

[0055] In other words, the power-off order generation unit **54** sequentially compares the column of the referrer **42**A with the column of the referent **42**B within the dependency list table **42**, excluding the dependency of the virtual machine **20** which has already been set to any place, and based on a result of the comparison, generates the power-off order of the virtual machines **20** in the power-off target physical machine **10**.

[0056] Furthermore, after setting all the virtual machines **20** being deployed on the power-off target physical machine **10** to the places in the power-off order, the power-off order generation unit **54** determines whether or not there is a virtual machine **20** which has the dependency on the virtual machine **20** on this power-off target physical machine **10** and is deployed on another physical machine **10**.

[0057] The power-off order generation unit **54** includes a dependency determination unit **54**A which, if there is the virtual machine **20** which has the dependency on the virtual machine **20** on the power-off target physical machine **10** and is deployed on another physical machine **10**, determines whether or not this virtual machine **20** has the dependency on another virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10**.

[0058] Moreover, the power-off order generation unit **54** includes a power-off order addition unit **54**B which, if it is determined by the dependency determination unit **54**A that the same virtual machine **20** has the dependency on another virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10**, excludes this virtual machine **20** from the power-off target.

[0059] Moreover, if it is determined by the dependency determination unit **54**A that the same virtual machine **20** has no dependency on another virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10**, the power-off order addition unit **54**B adds this virtual machine **20** to a predetermined place in the power-off order.

[0060] FIG. **8** is an explanatory diagram briefly depicting table contents of the power-off order management table **43** in the present embodiment.

[0061] The power-off order management table **43** depicted in FIG. **8** manages a power-off order **43**B in units **43**A of the physical machines **10**. For example, in the case of the physical machine of "PM**01**", the power-off order **43**B is set and managed so that the virtual machines **20** of "VM**11**" and "VM**15**" are set to the first place, the virtual machine **20** of "VM**12**" is set to the second place, the virtual machine **20** of "VM**13**" is set to the third place, and the virtual machine **20** of "VM**19**" is set to the fourth place.

[0062] Moreover, the server management control unit **38** depicted in FIG. **2** includes a command screen presentation unit **55** which presents a command screen to the client **6** through the GUI unit **31**, a target presentation unit **56** which, if an instruction for selecting the virtual machine **20** of the power-off target with respect to the virtual machines **20** on the command screen is detected, visually presents the power-off order of this virtual machine **20** of the power-off target and all the virtual machines **20** having the dependencies on the same virtual machine **20**, to the client **6** through the GUI unit **31**, and a virtual machine power control unit **57** which sequentially powers off the virtual machines **20** via the virtualization software control unit **36** based on this power-off order.

[0063] It should be noted that the virtual machine management unit **51**, the virtual machine list generation unit **52**, the dependency list generation unit **53**, the power-off order generation unit **54**, the command screen presentation unit **55**, the target presentation unit **56** and the virtual machine power control unit **57** are performed, for example, by software processes on the server management control unit **38**.

[0064] When a power-off start command from the client **6** is detected through the GUI unit **31**, the command screen presentation unit **55** presents a power-off command screen **70** (see FIGS. **13** and **14**) to the client **6**.

[0065] When an instruction for selecting the power-off target physical machine **10** on the power-off command screen **70** is detected through the GUI unit **31**, the target presentation unit **56** reads the power-off order in this power-off target based on the table contents of this power-off order management table **43**, and presents this read power-off order (see FIG. **14**) on the power-off command screen **70**, to the client **6** through the GUI unit **31**.

[0066] Moreover, when an instruction for selecting "OK" from the client **6** is detected through the GUI unit **31** while the power-off order regarding the power-off target virtual machines **20** is presented by the target presentation unit **56**, the virtual machine power control unit **57** sequentially powers off the power-off target virtual machines **20** through the virtualization software control unit **36** based on this power-off order.

[0067] Moreover, when the power-off with respect to all the power-off target virtual machines **20** is completed by the virtual machine power control unit **57**, the server management control unit **38** powers off the same power-off target physical machine **10** through the power control unit **35**.

[0068] It should be noted that while the configurations of the embodiment have been described above, correspondence relationships between constituent features of the embodiment and those described in the claims will be described. A computer apparatus and a management server apparatus

described in the claims correspond to the management server **5**, the physical machine **10** corresponds to the host machine **3** or the storage apparatus **4**, virtual machines described in the claims correspond to the virtual machines **20**, a virtual machine list table described in the claims corresponds to the virtual machine list table **41**, virtual machine list generation means described in the claims corresponds to the virtual machine list generation unit **52**, a dependency list table described in the claims corresponds to the dependency list table **42**, dependency list generation means described in the claims corresponds to the dependency list generation unit **53** and the virtualization software control unit **36**, a power-off order management table described in the claims corresponds to the power-off order management table **43**, power-off order generation means described in the claims corresponds to the power-off order generation unit **54**, and power-off execution means described in the claims corresponds to the power control unit **35** and the virtual machine power control unit **57**.

[0069] Next, operations of the virtual machine management system **1** of the present embodiment will be described. FIG. **9** is a flowchart depicting a processing operation of the server management control unit **38** within the management server **5**, regarding a virtual machine management process in the present embodiment.

[0070] The virtual machine management process depicted in FIG. **9** is a process of generating the virtual machine list table **41** which manages the virtual machines **20** in units of the physical machines **10**, and the dependency list table **42** which manages the dependencies among the virtual machines **20**, in units of the physical machines **10**, based on the connection states of the virtual machines **20**.

[0071] In FIG. **9**, the server management control unit **38** determines whether or not the management server **5** is in a power ON state (step S**11**).

[0072] If the management server **5** is in the power ON state (Yes at step S**11**), the server management control unit **38** determines whether or not the management information on the virtual machines **20** deployed on each physical machine **10** has been received through a management tool function of the virtualization software control unit **36** (step S**12**). It should be noted that the management tool function uses the management tool of the virtualization software to periodically collect the management information on the virtual machines **20** deployed on each physical machine **10**.

[0073] If the management information on the virtual machines **20** has been received (Yes at step S**12**), based on this management information, the virtual machine list generation unit **52** in the server management control unit **38** generates the virtual machine list table **41** (see FIG. **4**) which manages the plurality of virtual machines **20** deployed on the same physical machine **10**, in units of the physical machines **10** (step S**13**), and the process proceeds to step S**11** to monitor whether or not the management server **5** is in the power ON state.

[0074] Moreover, if the management information on the virtual machines **20** has not been received at step S**12** (No at step S**12**), the server management control unit **38** determines whether or not the connection states of the virtual machines **20** have been received through the monitoring functions of the virtual machines **20** (step S**14**). It should be noted that the monitoring function of the virtual machine **20** periodically confirms the connection state of the virtual machine **20** itself.

[0075] If the connection states of the virtual machines **20** have been received (Yes at step S**14**), based on the connection states of the virtual machines **20**, the dependency list generation unit **53** in the server management control unit **38** generates the dependency list table **42** (see FIG. **5**) which manages the information on the connection destinations among the virtual machines **20** in a one-to-one manner in the list form (step S**15**), and the process proceeds to step S**11** to monitor whether or not the management server **5** is in the power ON state.

[0076] Moreover, if the connection states of the virtual machines **20** have not been received at step S**14** (No at step S**14**), the server management control unit **38** proceeds to step S**11**.

[0077] Moreover, if the management server **5** is not in the power ON state at step S**11** (No at step S**11**), the server management control unit **38** completes this processing operation.

[0078] According to the virtual machine management process depicted in FIG. **9**, when, for each physical machine **10**, the management information on the virtual machines **20** deployed on the same physical machine **10** is periodically received through the management tool function of the virtualization software control unit **36**, the virtual machine list table **41** which manages the virtual machines **20** deployed on the same physical machine **10**, in the list form in units of the physical machines **10** is generated, and also, when the connection states of the virtual machines **20** are received through the monitoring functions of the virtual machines **20**, based on these connection states, the dependency list table **42** which manages the information on the connection destinations among the same virtual machines **20** in a one-to-one manner and thereby manages the dependencies among the virtual machines **20** in the list form in units of the physical machines **10** is generated. Therefore, on the management server **5** side, based on the table contents of the virtual machine list table **41**, the virtual machines **20** deployed on each physical machine **10** can be recognized, and also, based on the table contents of the dependency list table **42**, the dependencies among the respective virtual machines **20** can be recognized in units of the physical machines **10**.

[0079] Next, a power-off order setting process in the present embodiment will be described. FIG. **10** is a flowchart depicting a processing operation of the server management control unit **38** within the management server **5**, regarding the power-off order setting process in the present embodiment.

[0080] The power-off order setting process depicted in FIG. **10** is a process of setting the power-off order in which, for each physical machine **10**, of course, the virtual machines **20** deployed on the same physical machine **10**, and depending on conditions, also the virtual machines **20** having the dependencies on the same virtual machines **20** are sequentially powered off.

[0081] In FIG. **10**, the power-off order generation unit **54** in the server management control unit **38** identifies the virtual machine **20** having the highest dependency, in units of the physical machines **10**, based on the table contents of the virtual machine list table **41** and the dependency list table **42** (step S**21**).

[0082] It should be noted that, as depicted in FIG. **6**, the power-off order generation unit **54** compares the virtual machine list table **41** of the power-off target physical machine **10** with the referent **42**B in the dependency list table **42** of the same power-off target physical machine **10**, and identifies the virtual machine **20** which does not exist in the column of the referent **42**B in the dependency list table **42**, from the virtual

machines **20** being deployed on the power-off target physical machine **10**, as the virtual machine **20** having the highest dependency.

[0083] The power-off order generation unit **54** sets the virtual machine **20** having the highest dependency at step S**21** to the first place in the power-off order (step S**22**), and identifies the virtual machine **20** having the highest dependency, from the virtual machines **20** on the power-off target physical machine **10** in a state where the dependency of the virtual machine **20** which has already been set to any power-off place has been excluded (step S**23**). It should be noted that the power-off order generation unit **54** sets and manages the places in the power-off order, in the power-off order management table **43**, in a manner corresponding to the virtual machine **20** having the highest dependency.

[0084] Moreover, at step S**23**, the power-off order generation unit **54** compares the column of the referrer **42**A with the column of the referent **42**B in the dependency list table **42** depicted in FIG. **7**, in a state where the dependency of the virtual machine **20** which has already been set to any power-off place has been excluded from the column of the referrer **42**A and the column of the referent **42**B, and identifies the virtual machine **20** which does not exist in the column of the referent **42**B, from the virtual machines **20** in the column of the referrer **42**A, as the virtual machine **20** having the higher dependency.

[0085] The power-off order generation unit **54** sets the virtual machine **20** identified at step S**23** to a next place in the power-off order (step S**24**). It should be noted that the next place means that the place of the power-off target which has been immediately previously set is incremented by 1.

[0086] When the power-off order generation unit **54** has set the virtual machine **20** to the next place in the power-off order at step S**24**, the power-off order generation unit **54** determines whether or not all the virtual machines **20** on the power-off target physical machine **10** have been completely set to the places in the power-off order (step S**25**).

[0087] If all the virtual machines **20** on the power-off target physical machine **10** have not been completely set to the places in the power-off order (No at step S**25**), the power-off order generation unit **54** proceeds to step S**23** to identify the virtual machine **20** having a next highest dependency. It should be noted that, as a result thereof, in the dependencies depicted in FIG. **3**, if it is assumed that the power-off target physical machine **10** is "PM**01**", the power-off order is set so that "VM**11**" and "VM**15**" are set to the first place, "VM**12**" is set to the second place, "VM**13**" is set to the third place, and "VM**19**" is set to the fourth place.

[0088] If all the virtual machines **20** on the power-off target physical machine **10** have been completely set to the places in the power-off order (Yes at step S**25**), the power-off order generation unit **54** determines whether or not there is the virtual machine **20** which has the dependency on the virtual machine **20** on the power-off target physical machine **10** and is on another physical machine **10**, based on the table contents of the dependency list table **42** corresponding to the power-off target physical machine **10**, through the dependency determination unit **54**A (step S**26**).

[0089] If there is no virtual machine **20** which has the dependency on the virtual machine **20** on the power-off target physical machine **10** and is on another physical machine **10** (No at step S**26**), the power-off order generation unit **54** completes this processing operation.

[0090] If there is the virtual machine **20** which has the dependency on the virtual machine **20** on the power-off target physical machine **10** and is on another physical machine **10** (Yes at step S**26**), for example, as depicted in FIGS. **3** and **5**, if there is the virtual machine **20** of "VM**22**" which has the dependency on the virtual machine **20** of "VM**11**" on the power-off target physical machine **10** of "PM**01**" and is on the physical machine **10** of "PM**02**", the power-off order generation unit **54** determines whether or not this virtual machine **20** on another physical machine **10** has the dependency on the virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10** (step S**27**).

[0091] If the virtual machine **20** on another physical machine **10** has the dependency on the virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10** (Yes at step S**27**), for example, as depicted in FIGS. **3** and **5**, if the virtual machine **20** of "VM**22**" on the physical machine **10** of "PM**02**" has the dependency on the virtual machine **20** of "VM**26**" other than the virtual machines **20** on the power-off target physical machine **10** of "PM**01**", the power-off order generation unit **54** excludes the virtual machine **20** of "VM**22**" from the power-off order in the power-off target physical machine **10**, through the power-off order addition unit **54**B (step S**28**).

[0092] When the power-off order generation unit **54** has excluded the virtual machine **20** of "VM**22**" from the power-off order at step S**28**, the power-off order generation unit **54** proceeds to step S**26** to determine whether or not there is further the virtual machine **20** which has the dependency on the virtual machine **20** on the power-off target physical machine **10** and is on another physical machine **10**.

[0093] Moreover, if the virtual machine **20** on another physical machine **10** has no dependency on the virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10** (No at step S**27**), for example, as depicted in FIG. **11**, if the virtual machine **20** of "VM**22**" on the physical machine **10** of "PM**02**" has no dependency on the virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10** of "PM**01**", the power-off order generation unit **54** sets this virtual machine **20** ("VM**22**" in the case of FIG. **11**) to the predetermined place in the power-off order so as to set this virtual machine **20** as the power-off target, through the power-off order addition unit **54**B (step S**29**). It should be noted that the predetermined place is assumed to be set, for example, to a lowest place in the power-off places.

[0094] When the power-off order generation unit **54** has set the virtual machines **20** ("VM**22**" in the case of FIG. **11**) to the predetermined place as the power-off target at step S**29**, the power-off order generation unit **54** proceeds to step S**26** to determine whether or not there is further the virtual machine **20** which has the dependency on the virtual machine **20** on the power-off target physical machine **10** and is on another physical machine **10**.

[0095] According to the power-off order setting process depicted in FIG. **10**, based on the table contents of the virtual machine list table **41** and the dependency list table **42**, the places in the power-off order of the virtual machines **20** are set in descending order of dependency, in units of the physical machines **10**. Therefore, the places in the power-off order can be automatically set in descending order of dependency.

[0096] Moreover, according to the power-off order setting process, even in the case where the virtual machine **20** deployed on the power-off target physical machine **10** has the

dependency on the virtual machine **20** on another physical machine **10**, if this virtual machine **20** on another physical machine **10** has the dependency on the virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10**, the same virtual machine **20** is excluded from the power-off order. Therefore, an effect of the power-off of the virtual machine **20** having the dependency on the virtual machine **20** deployed on the power-off target physical machine **10** can be prevented from occurring.

[0097] Moreover, according to the power-off order setting process, even in the case where the virtual machine **20** deployed on the power-off target physical machine **10** has the dependency on the virtual machine **20** on another physical machine **10**, if this virtual machine **20** on another physical machine **10** has no dependency on the virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10**, the same virtual machine **20** is added to the predetermined place in the power-off order. Therefore, the virtual machine **20** having the dependency on the virtual machine **20** deployed on the power-off target physical machine **10** can also be set to the predetermined place in the power-off order.

[0098] Next, a physical machine power-off process in the present embodiment will be described. FIG. **12** is a flowchart depicting a processing operation of the server management control unit **38** within the management server **5**, regarding the physical machine power-off process in the present embodiment.

[0099] The physical machine power-off process depicted in FIG. **12** is a process of, when the instruction for selecting the power-off target physical machine **10** is detected, sequentially powering off, of course, the power-off target physical machine **10** and the virtual machines **20** deployed on this physical machine **10**, and depending on the conditions, also the virtual machines **20** having the dependencies on these power-off target virtual machines **20**, based on the power-off order.

[0100] In FIG. **12**, the server management control unit **38** determines whether or not the power-off start command from the client **6** has been detected through the GUI unit **31** (step S**31**).

[0101] If the power-off start command has been detected (Yes at step S**31**), the command screen presentation unit **55** in the server management control unit **38** presents the power-off command screen **70** depicted in FIG. **13** to the client **6** through the GUI unit **31** (step S**32**).

[0102] Moreover, based on the table contents of the virtual machine list table **41**, the target presentation unit **56** in the server management control unit **38** presents the physical machines **10** being managed by this management server **5**, on the power-off command screen **70** (step S**33**). It should be noted that a user on the client **6** side can visually recognize the physical machines **10** being managed by the management server **5**, that is, the power-off target physical machines **10**, based on contents presented on a power-off command screen **70**A depicted in FIG. **13**.

[0103] The server management control unit **38** determines whether or not the instruction for selecting the power-off target physical machine **10** has been detected on the power-off command screen **70**A through the GUI unit **31** (step S**34**).

[0104] If the instruction for selecting the power-off target physical machine **10** has been detected (Yes at step S**34**), based on the table contents of the power-off order management table **43**, the target presentation unit **56** in the server management control unit **38** presents the power-off order in the power-off target physical machine **10**, on the power-off command screen **70** through the GUI unit **31**, as depicted in FIG. **14** (step S**35**). It should be noted that the user on the client **6** side can visually recognize the dependencies among all the power-off target virtual machines **20**, based on screen contents of a power-off command screen **70**B depicted in FIG. **14**.

[0105] The server management control unit **38** determines whether or not the instruction for selecting "OK" from the client **6** on the power-off command screen **70**B so as to request execution of the power-off of all the power-off target virtual machines **20** being currently presented has been detected through the GUI unit **31** (step S**36**).

[0106] If the instruction for selecting "OK" has been detected (Yes at step S**36**), based on the table contents of the power-off order management table **43**, the virtual machine power control unit **57** in the server management control unit **38** designates the virtual machine **20** at a higher place among all these power-off target virtual machines **20** based on the power-off order (step S**37**), and powers off the same virtual machine **20** in a software manner through the virtualization software control unit **36** (step S**38**). It should be noted that if a plurality of power-off target virtual machines **20** have been designated at step S**37**, the plurality of virtual machines **20** are simultaneously powered off in a process at step S**38**.

[0107] When the virtual machine power control unit **57** has powered off the virtual machine **20** in a software manner at step S**38**, the virtual machine power control unit **57** determines whether or not the power-off of all the virtual machines **20** related to the power-off target physical machine **10** has been completed (step S**39**).

[0108] If the power-off of all the virtual machines **20** related to the power-off target physical machine **10** has been completed (Yes at step S**39**), the power control unit **35** powers off this power-off target physical machine **10** through the machine side power control unit **3**B of the same physical machine **10** (step S**40**).

[0109] When the target presentation unit **56** has detected the power-off of the power-off target physical machine **10**, the target presentation unit **56** presents a power-off completion message to the client **6** through the GUI unit **31** (step S**41**). The power-off completion message indicates that the power-off of, of course, this power-off target physical machine **10**, and all the virtual machines **20** related to the physical machine **10**, based on the power-off order, has been completed. Thereby, this processing operation is completed. It should be noted that the user on the client **6** side can recognize that the power-off of the power-off target physical machine **10** has been completed, based on the power-off completion message.

[0110] Moreover, if the power-off of all the virtual machines **20** related to the power-off target physical machine **10** has not been completed at step S**39** (No at step S**39**), the virtual machine power control unit **57** proceeds to step S**37** to designate the virtual machine **20** at the next place to be powered off next, based on the power-off order.

[0111] Moreover, if the instruction for selecting "OK" from the client **6** on the power-off command screen **70**B has not been detected at step S**36** (No at step S**36**), the server management control unit **38** determines whether or not an instruction for selecting "cancel" on the power-off command screen **70**B has been detected (step S**42**).

[0112] If the instruction for selecting "cancel" on the power-off command screen **70**B has been detected (Yes at step S**42**), the server management control unit **38** completes this processing operation.

[0113] Moreover, if the instruction for selecting "cancel" has not been detected at step S**42** (No at step S**42**), the server management control unit **38** proceeds to step S**36** to determine whether or not the instruction for selecting "OK" has been detected.

[0114] Moreover, if the power-off start command has not been detected at step S**31** (No at step S**31**), the server management control unit **38** completes this processing operation.

[0115] Moreover, if the instruction for selecting the power-off target virtual machine **20** has not been detected at step S**34** (No at step S**34**), the server management control unit **38** continues a monitoring operation at step S**34** to monitor the detection of the instruction for selecting the power-off target virtual machine **20**.

[0116] According to the physical machine power-off process depicted in FIG. **12**, when the instruction for selecting the power-off target physical machine **10** is detected, based on the table contents of the power-off order management table **43**, the power-off order corresponding to this power-off target physical machine **10** is visually presented to the client **6** side. Therefore, the user on the client **6** side can visually recognize the power-off order of the virtual machines **20** related to the power-off target physical machine **10**, based on presented contents thereof.

[0117] Moreover, according to the physical machine power-off process, if the instruction for selecting "OK" with respect to this power-off order has been detected while the power-off order of the virtual machines **20** related to the power-off target physical machine **10** is presented, the power-off target virtual machines **20** are sequentially powered off in descending order of dependency, based on this power-off order, and the power-off target physical machine **10** is finally powered off. Therefore, even if there are a plurality of virtual machines **20** having the dependencies among them, the plurality of virtual machines **20** having the dependencies among them can be powered off in a simple operation. Accordingly, it is possible to intend, of course, to reduce a work time required for the power-off, and also to significantly reduce a work burden thereof.

[0118] According to the present embodiment, based on the table contents of the virtual machine list table **41** and the dependency list table **42**, from the virtual machines **20** deployed on the power-off target physical machine **10** and the virtual machines **20** having the dependencies on these virtual machines **20**, the power-off order management table **43** which manages the power-off order in which the same virtual machines **20** are sequentially powered off in descending order of dependency, in units of the physical machines **10**, is generated. Based on the table contents of this power-off order management table **43**, when the instruction for selecting the power-off target physical machine **10** is detected, the power-off order corresponding to this power-off target physical machine **10** is visually presented. Therefore, even the user other than the specific system administrator can identify the power-off order in the power-off target physical machine **10** based on the presented contents thereof, and thereby easily power off this power-off target physical machine **10** including the virtual machines **20** dependent on the power-off target physical machine **10**, without any complicated operational burden.

[0119] Moreover, according to the present embodiment, when the instruction for selecting "OK" is detected while the power-off order indicating the dependencies among all the virtual machines **20** related to the power-off target physical machine **10** is presented, the virtual machines **20** are sequentially powered off in descending order of dependency, based on this power-off order. Therefore, since all these power-off target virtual machines **20** can be sequentially powered off in the simple operation, it is possible to intend to significantly reduce the work burden of the power-off while the reduction in the work time required for the power-off is intended.

[0120] Moreover, according to the present embodiment, even in the case where the virtual machine **20** deployed on the power-off target physical machine **10** has the dependency on the virtual machine **20** on another physical machine **10**, if this virtual machine **20** on another physical machine **10** has the dependency on the virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10**, the same virtual machine **20** is excluded from the power-off order. Therefore, the effect of the power-off of the virtual machine **20** having the dependency on the virtual machine **20** deployed on the power-off target physical machine **10** can be prevented from occurring.

[0121] Moreover, according to the present embodiment, even in the case where the virtual machine **20** deployed on the power-off target physical machine **10** has the dependency on the virtual machine **20** on another physical machine **10**, if this virtual machine **20** on another physical machine **10** has no dependency on the virtual machine **20** other than the virtual machines **20** on the power-off target physical machine **10**, the same virtual machine **20** is added to the predetermined place in the power-off order. Therefore, the virtual machine **20** having the dependency on the virtual machine **20** deployed on the power-off target physical machine **10** can also be set to the predetermined place in the power-off order.

[0122] It should be noted that, in the present embodiment, based on the table contents of the power-off order management table **43**, when the instruction for selecting "OK" is detected while the power-off order indicating the dependencies among all the virtual machines **20** related to the power-off target physical machine **10** is presented, all the virtual machines **20** related to the power-off target physical machine **10** and the physical machine **10** are automatically powered off, while, of course, the virtual machines **20** and the physical machine **10** of the power-off targets may be manually and sequentially powered off.

[0123] Moreover, in the present embodiment, the virtual machine management system **1** in cooperation with the plurality of virtual machines **20** deployed on a plurality of physical machines **10** has been described by way of example. However, of course, a system in which the plurality of virtual machines **20** deployed on one physical machine **10** cooperate with one another can also provide a similar advantageous effect.

[0124] Moreover, in the present embodiment, in the power-off order setting process depicted in FIG. **10**, the power-off order is previously managed in the power-off order management table **43**, in units of the power-off target physical machines **10**. However, of course, the similar advantageous effect can also be provided if, for example, at a timing when the instruction for selecting the power-off target physical machine **10** on the power-off command screen **70**A has been detected at step S**34** depicted in FIG. **12**, the power-off order setting process of setting the power-off order of the virtual machines **20** related to the power-off target physical machine **10** is executed, and the power-off order is managed in the power-off order management table **43**, in units of the physical machines **10**.

[0125] Moreover, in the present embodiment, it has been described that the virtual machine **20** ("VM**22**" in the case of

FIG. **11**) is set to the lowest place in the power-off order, as the predetermined place in the power-off order, at step S**29** of FIG. **10**. However, of course, the place in the power-off order may be set in consideration of the dependency between the virtual machine **20** on the power-off target physical machine **10** and the same virtual machine **20** of "VM**22**".

[0126] Moreover, in the present embodiment, the physical machine **10** is powered off by controlling the machine side power control unit **3**B in the physical machine **10** through the power control unit **35** in the management server **5**. However, for example, if the physical machine **10** controls its power through an uninterruptible power supply apparatus, of course, the uninterruptible power supply apparatus is controlled through the power control unit **35** to power off the physical machine **10**.

[0127] Moreover, in the present embodiment, the virtual machines **20** related to the power-off target physical machine **10** are powered off in descending order of dependency, that is, based on the power-off order. However, the virtual machine **20** having no dependency is directly powered off, which, of course, can reduce a time required for a power-off task.

[0128] Hereinabove, although the embodiment of the present invention has been described, the range of the technical idea of the present invention is not limited by the present embodiment, and of course, various embodiments can be practiced as long as those embodiments do not deviate from the range of the technical idea described in the claims. Moreover, the advantageous effects described in the present embodiment are not limited thereto.

[0129] Moreover, among the various processes described in the present embodiment, of course, all or some of the processes described to be automatically performed can also be manually performed, and conversely, of course, all or some of the processes described to be manually performed can also be automatically performed. Moreover, of course, processing procedures, control procedures, specific names, and information including various data or parameters, which have been described in the present embodiment, can also be altered as appropriate, if not otherwise specified.

[0130] Moreover, respective components of respective apparatuses depicted in the drawings have been described in terms of functional concepts, and are not necessarily physically configured as depicted in the drawings, and of course, specific aspects of the respective apparatuses are never limited or reduced to those depicted in the drawings.

[0131] Furthermore, of course, all of various processing functions performed in the respective apparatuses, or arbitrarily, some of those may be executed on a CPU (Central Processing Unit) (or a microcomputer such as an MPU (Micro Processing Unit) or an MCU (Micro Controller Unit)), on a program which is analyzed and executed by the same CPU (or the microcomputer such as the MPU or the MCU), or on hardware with wired logic.

What is claimed is:

1. A recording medium having recorded therein a virtual machine management program for causing a computer apparatus which causes arbitrary virtual machines among a plurality of virtual machines deployed on a physical machine to execute a control process in cooperation with one another, to execute a process of managing the plurality of virtual machines, the virtual machine management program causing the computer apparatus to execute:

a virtual machine detection procedure for detecting the virtual machines deployed on the physical machine,

a virtual machine list generation procedure for, based on a result of the detection by the virtual machine detection procedure, generating a virtual machine list table which manages virtual machine identification information for identifying the virtual machines deployed on the physical machine;

a dependency detection procedure for detecting dependencies among the virtual machines deployed on the physical machine;

a dependency list generation procedure for, based on a result of detection by the dependency detection procedure, generating a dependency list table which manages the dependence of the virtual machine identification information;

a power-off order generation procedure for, based on table contents of the virtual machine list table and the dependency list table, from the virtual machines deployed on the physical machine of a power-off target and the virtual machines having the dependencies on these virtual machines, generating a power-off order management table which manages a power-off order in which the same virtual machines are sequentially powered off in descending order of dependency, in units of said physical machine; and

a target presentation procedure for, when an instruction for selecting the power-off target physical machine is detected, reading the power-off order corresponding to the power-off target physical machine from the power-off order management table, and visually presenting the read power-off order.

2. The recording medium having recorded therein the virtual machine management program according to claim **1**, wherein said virtual machine management program causes said computer apparatus to execute a power-off execution procedure for, when an instruction for starting said power-off is detected while the power-off order corresponding to said power-off target physical machine is presented in said target presentation procedure, based on said power-off order, sequentially powering off the virtual machines on said power-off target physical machine and the virtual machines having the dependencies on these virtual machines, and subsequently, powering off this power-off target physical machine.

3. The recording medium having recorded therein the virtual machine management program according to claim **2**, wherein said power-off order generation procedure causes said computer apparatus to execute:

a dependency determination procedure for, if there is a virtual machine deployed on another physical machine, among the virtual machines having the dependencies on the virtual machines deployed on said power-off target physical machine, determining whether or not this virtual machine deployed on another physical machine has the dependency on another virtual machine other than the virtual machines deployed on said power-off target physical machine; and

a power-off order exclusion procedure for, in this dependency determination procedure, if said virtual machine deployed on another physical machine has the dependency on another virtual machine other than the virtual machines deployed on said power-off target physical machine, excluding this virtual machine from said power-off target.

4. The recording medium having recorded therein the virtual machine management program according to claim **3**, wherein said power-off order generation procedure causes said computer apparatus to execute:

a power-off order addition procedure for, in said dependency determination procedure, if said virtual machine deployed on another physical machine has no dependency on another virtual machine other than the virtual

machines deployed on said power-off target physical machine, adding this virtual machine as said power-off target to said power-off order.

5. A management server apparatus which manages a physical machine, also manages a plurality of virtual machines deployed on this physical machine, and enables arbitrary virtual machines among the plurality of virtual machines to execute a control process in cooperation with one another, the server comprising:

a virtual machine detector for detecting the virtual machines deployed on the physical machine,

a virtual machine list generator for, based on a result of the detection by the virtual machine detector, generating a virtual machine list table which manages virtual machine identification information for identifying the virtual machines deployed on the physical machine;

a dependency detector for detecting dependencies among the virtual machines deployed on the physical machine;

a dependency list generator for, based on a result of detection by the dependency detector, generating a dependency list table which manages the dependence of the virtual machine identification information;

a power-off order generator for, based on table contents of the virtual machine list table and the dependency list table, from the virtual machines deployed on the physical machine of a power-off target and the virtual machines having the dependencies on these virtual machines, generating a power-off order management table which manages a power-off order in which the same virtual machines are sequentially powered off in descending order of dependency, in units of said physical machine; and

a target presentation unit for, when an instruction for selecting the power-off target physical machine is detected, reading the power-off order corresponding to the power-off target physical machine from the power-off order management table, and visually presenting the read power-off order.

6. The management server apparatus according to claim **5**, further comprising:

power-off execution unit for, when an instruction for starting said power-off is detected while the power-off order corresponding to the power-off target physical machine is presented by the target presentation unit, based on the power-off order, sequentially powers off the virtual machines on the power-off target physical machine and the virtual machines having the dependencies on these virtual machines, and subsequently, powers off this power-off target physical machine.

7. The management server apparatus according to claim **6**, wherein the power-off order generator comprises:

dependency determination unit which, if there is a virtual machine deployed on another physical machine, among the virtual machines having the dependencies on the virtual machines deployed on said power-off target physical machine, determines whether or not this virtual machine deployed on another physical machine has the dependency on another virtual machine other than the virtual machines deployed on said power-off target physical machine; and

power-off order exclusion unit which, in this dependency determination means, if the virtual machine deployed on another physical machine has the dependency on another virtual machine other than the virtual machines deployed on said power-off target physical machine, excludes this virtual machine from said power-off target.

8. The management server apparatus according to claim **7**, wherein said power-off order generation means further comprises:

power-off order addition unit which, in the dependency determination means, if the virtual machine deployed on another physical machine has no dependency on another virtual machine other than the virtual machines deployed on the power-off target physical machine, adds the virtual machine as the power-off target to the power-off order.

9. A virtual machine management method which enables arbitrary virtual machines among a plurality of virtual machines deployed on a physical machine to execute a control process in cooperation with one another, and manages said plurality of virtual machines, the method comprising:

a virtual machine detection procedure for detecting the virtual machines deployed on the physical machine,

a virtual machine list generation procedure for, based on a result of the detection by the virtual machine detection procedure, generating a virtual machine list table which manages virtual machine identification information for identifying the virtual machines deployed on the physical machine;

a dependency detection procedure for detecting dependencies among the virtual machines deployed on the physical machine;

a dependency list generation procedure for, based on a result of detection by the dependency detection procedure, generating a dependency list table which manages the dependence of the virtual machine identification information;

a power-off order generation procedure for, based on table contents of the virtual machine list table and the dependency list table, from the virtual machines deployed on the physical machine of a power-off target and the virtual machines having the dependencies on these virtual machines, generating a power-off order management table which manages a power-off order in which the same virtual machines are sequentially powered off in descending order of dependency, in units of said physical machine; and

a target presentation procedure for, when an instruction for selecting the power-off target physical machine is detected, reading the power-off order corresponding to the power-off target physical machine from the power-off order management table, and visually presenting the read power-off order.

10. The virtual machine management method according to claim **9**, further comprising:

a power-off execute procedure, when an instruction for starting said power-off is detected while the power-off order corresponding to the power-off target physical machine is presented at the target presentation procedure, based on the power-off order, sequentially powering off the virtual machines on the power-off target physical machine and the virtual machines having the dependencies on these virtual machines, and subsequently, powering off this power-off target physical machine.

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